SURFACE-WATER EVAPORATION STUDY
ROCKY FLATS PLANT

Task 15
of the
Zero-Offsite Water-Discharge Study

Prepared For:

EG&G ROCKY FLATS, INC.
Facilities Engineering
Plant Civil-Structural Engineering
P.O. Box 464
Golden, CO 80402-0464

EG&G Job Number 401009
BOA Contract BA72429PB
Purchase Order No. BA76637GS

Prepared By:

ADVANCED SCIENCES, INC.
405 Urban Street, Suite 401
Lakewood, CO 80228

Draft: April 23, 1991
Final: May 7, 1991

ASI Project No. 208.0115

DISCLAIMER

This report was prepared as a result of work sponsored by a contractor to an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any contractor or subcontractor, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness or any information, apparatus, product, or process disclosed, or represents that its use would not infringe upon privately owned rights. Reference herein to any specific commercial product, process, or service, any trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of the authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

TABLE OF CONTENTS

SECTION			PAGE
EXECUTIVE SUMMARY			v
1.0	INTRODUCTION		1
	1.1	BACKGROUND	1
	1.2	PURPOSE OF STUDY	1
2.0	FREE-WATER SURFACE EVAPORATION		3
	2.1	GENERAL	3
		2.1.1 Definition	3
		2.1.2 Nature of the Process	3
	2.2	METHODS OF DETERMINING EVAPORATION	5
		2.2.1 Evaporation Pans	5
		2.2.2 Water-Budget Determinations	7
		2.2.3 Dalton's Law Equations	7
3.0	REGIONAL TOTAL PAN EVAPORATION DATA SOURCES		9
	3.1	NATIONAL WEATHER SERVICE OBSERVATION STATIONS	9
	3.2	OTHER SOURCES OF EVAPORATION DATA	9
4.0	CALCULATION OF ROCKY FLATS PLANT EVAPORATION		12
	4.1	FREE-WATER SURFACE EVAPORATION	12
		4.1.1 Estimation of Rocky Flats Plant Total Pan Evaporation	12
		4.1.2 Conversion to Net Reservoir Evaporation	17
	4.2	SPRAY EVAPORATION	19
5.0	EVAPORATION POND SIZING		22
	5.1	FREE-WATER SURFACE EVAPORATION POND	22
	5.2	SPRAY EVAPORATION POND	23
			25
6.0	PRELIMINARY ENVIRONMENTAL ANALYSIS		26
7.0	ACKNOWLEDGEMENTS		27
8.0	REFERENCES		28

TABLE OF CONTENTS
(continued)

List of Tables

		PAGE
Table 1	Comparison of Average Total (April through October) Pan Evaporation from the Seven NWS Locations and Cherry Creek Dam	11
Table 2	Average Calculated Meyer C Values From Fort Collins Total Pan Evaporation (1953 Through 1989) April Through October	13
Table 3	Calculated RFP Total Monthly Pan Evaporation and Corresponding Fort Collins Pan Evaporation	15
Table 4	Net Annual Reservoir Evaporation	18
Table 5	Evaporation Pond Sizing For Free-Water Surface Evaporation	24
Table 6	Evaporation Pond Sizing For Spray Evaporation	25

List of Figures

Figure 1	Location of Evaporation Stations
Figure 2	Comparison of Total Pan Evaporation (Cherry Creek Dam, Fort Collins, Rocky Flats)
Figure 3	Comparison of Total Pan Evaporation (Pueblo WSO AP, Pueblo Reservoir, Rocky Flats)
Figure 4	Comparison of Total Pan Evaporation (Springfield 7 WSW, Trinidad Lake, Rocky Flats)
Figure 5	Comparison of Total Pan Evaporation (Akron 4 E, Bonny Lake, Rocky Flats)

TABLE OF CONTENTS
(concluded)

List of Appendices

Appendix A Comparison of Monthly Total Pan Evaporation (April Through October)

Appendix B Meyer C Calculations

Appendix C Rocky Flats Total Monthly Pan Evaporation Calculations

Appendix D Comparison of Rocky Flats and Fort Collins Meteorological Data

Appendix E Comparison of Total Monthly Pan Evaporation (January 1948 Through December 1990)

SURFACE-WATER EVAPORATION STUDY

Rocky Flats Plant

EXECUTIVE SUMMARY

This report has been prepared for one of several studies being conducted for, and in the development of, a Zero-Offsite Water-Discharge Plan for Rocky Flats Plant (RFP) in response to Item C.7 of the Agreement in Principle (AIP) between the Colorado Department of Health (CDH) and the U.S. Department of Energy (DOE) (DOE and State of Colorado, 1989). The CDH/DOE Agreement Item C.7 states "Source Reduction and Zero Discharge Study: Conduct a study of all available methods to eliminate Rocky Flats discharges to the environment including surface waters and ground water. This review should include a source reduction review" (AIP, p. 8).

Specifically, this report addresses important issues related to surface-water evaporation by the free-water surface and spray methods. This study evaluates regional sources of free-water surface evaporation data and spray evaporation data. The data are used with existing RFP data to estimate on-site net annual reservoir evaporation and spray evaporation. The results are used to estimate pond sizes for evaporation of sanitary treatment plant (STP) effluent, storm runoff, and ground water.

The calculated RFP net annual reservoir evaporation was determined to be 31.34 or 28.82 inches/year, depending on the annual pan evaporation coefficient used. These rates were greater than the regional rates. However, these values were calculated from only 13 months of RFP data. Calculations from long-term RFP data may produce more conclusive results. By assuming a pond depth of 31.34 to 28.82 inches (net annual reservoir evaporation rates), the corresponding free-water surface evaporation pond sizes were calculated to be 96 to 416 acres for flow rates of 250 to 1,000 acre-feet/year, respectively.

An average annual spray evaporation percentage of 66.2 percent was obtained from Merrick & Company (1990). Pond depths of 5 to 35 feet were assumed, resulting in spray evaporation pond areas of 2 to 17 acres for a flow rate of 250 acre-feet/year; 5 to 34 acres for 500 acre-feet/year; and 10 to 68 acres for 1000 acre-feet/year.

SURFACE-WATER EVAPORATION STUDY
Rocky Flats Plant

1.0 INTRODUCTION

1.1 BACKGROUND

This report has been prepared for one of several studies being conducted for, and in the development of, a Zero-Offsite Water-Discharge Plan for Rocky Flats Plant (RFP) in response to Item C.7 of the Agreement in Principle (AIP) between the Colorado Department of Health (CDH) and the U.S. Department of Energy (DOE) (DOE and State of Colorado, 1989). The CDH/DOE Agreement Item C.7 states "Source Reduction and Zero Discharge Study: Conduct a study of all available methods to eliminate Rocky Flats discharges to the environment including surface waters and ground water. This review should include a source reduction review" (AIP, p. 8).

The concept of Zero-Offsite Water-Discharge at the RFP could include evaporation of sanitary treatment plant (STP) effluent, storm runoff, and ground water. This Surface-Water Evaporation Study (ASI,1990) provides a compilation of total pan evaporation data measured by the National Weather Service (NWS) and other sources in eastern Colorado. On-site free-water surface and spray evaporation rates are estimated from these data and available on-site meteorological data in order to estimate evaporation pond sizes necessary to accommodate various pond-inflow rates.

1.2 PURPOSE OF STUDY

The purpose of this study is to estimate on-site net surface-water evaporation rates and to estimate the storage areas needed for a free-water surface evaporation system and spray evaporation system (ASI, 1990). This study provides a compilation of pan evaporation data from National Weather Service (NWS) observation sites in eastern Colorado, as well as data from other sources. Pan evaporation rates at the RFP are estimated from 13 months of on-site temperature, wind-speed, and dew-point data in conjunction with Dalton's law of evaporation and vapor pressure (Dalton, 1802). The monthly constants for the Dalton's law equation were calculated from the Fort Collins NWS data. Winter month gaps in the data were supplemented with evaporation data from Cherry Creek Dam. The annual total evaporation rate was converted to a net evaporation rate by subtracting on-site annual precipitation. In addition, spray evaporation as a percentage of flow rate was obtained from Merrick & Company (1990) and was used to estimate the size of the evaporation pond required.

2.0 FREE-WATER SURFACE EVAPORATION

2.1 GENERAL

2.1.1 Definition

Evaporation is the process by which the transfer of heat or energy changes water from the liquid state into the gaseous state (Chow, 1964). The energy transfer from the overlying air to the water surface occurs through radiation and conduction.

2.1.2 Nature of the Process

The transformation from liquid phase to gas phase occurs when molecules in the water mass have attained sufficient kinetic energy to eject from the water surface. The motion of the escaping molecules produces vapor pressure, which is also known as the partial pressure of the water vapor in the atmosphere. Saturation or equilibrium occurs when the number of escaping molecules equals the number of returning molecules, resulting in the equalization of vapor pressure and atmospheric pressure, causing the evaporation rate to equal zero (Chow, 1964).

2.1.3 Factors Affecting Evaporation Rates

The rate of evaporation is directly proportional to the difference between the vapor pressure exerted by the water body and that exerted by the air above the water surface. This fact is known as Dalton's Law (of evaporation and vapor pressure) (Chow, 1964). Quantitative evaluation of evaporation factors is difficult due to varying degrees of interdependence. In general, vapor pressures are dependent upon water and air temperatures, wind temperature and speed, atmospheric pressure, water quality, and the nature and shape of the evaporative surface (Chow, 1964).

As water temperature increases, so does the kinetic energy of the water molecules, resulting in increased vapor pressure. However, a simultaneous increase in air temperature increases the atmospheric pressure, resulting in a decreased difference between vapor and atmospheric pressures. In addition, if increased water temperature does increase evaporation, the process of evaporation will result in cooling of the water. Unless heat is continually supplied to the water, evaporation will begin to decrease. This has a significant effect with respect to estimating evaporation rates from water bodies because a large, deep, thermally stratified lake could react much differently from a shallow pond due to the heat storage capacity of water. Based upon temperature effects alone, a large, deep stratified water body may evaporate relatively less water in the spring, when the solar heating of the water lags behind that of the overlying air. The same water body would tend to evaporate relatively more water in the fall because it has not yet cooled to the temperature of the overlying air (Chow, 1964).

Wind affects evaporation by replacing water-laden air with unsaturated air. To an extent, an increase in wind speed would tend to increase evaporation; however, once the speed is great enough to remove water molecules from the overlying air as soon as they eject from the water surface, an additional increase in wind speed will have no significant effect. Generally, large, deep water bodies require turbulent winds of higher velocity to achieve maximum evaporation rates than small, shallow evaporation pans. Wind temperature also can affect evaporation rate by supplying or surrendering energy to the overlying air or the water body (Chow, 1964). Assuming all other factors are constant, a doubling of wind speed would temporarily double evaporation. However, the resulting evaporation would extract heat from the water surface faster than the overlying air could replace it. Consequently, the evaporation rate would begin to decrease. According to Linsley, Kohler, and Paulhus (1958), a 10 percent change in wind speed on a long-term basis will change evaporation only 1 percent to 3 percent.

Assuming all other factors to be constant, a decrease in barometric pressure would tend to increase evaporation. However, if the pressure change is due to a change in altitude, the effect may be compensated for by the corresponding change in vapor pressure (Chow, 1964).

Water quality, with respect to soluble solids, may also affect the evaporation rate. The addition of a solute would tend to reduce the vapor pressure, assuming all other factors are constant. The reduced vapor pressure results in a smaller pressure gradient at the air-water interface, decreasing the evaporation rate. This effect, if isolated from other factors, is quantifiable by Raoult's law. In general, the evaporation rate decreases about 1 percent per 1 percent increase in specific gravity. Consequently, evaporation is 2 to 3 percent less from sea water than from fresh water (Chow, 1964).

The nature and shape of the evaporating surface also affects evaporation. A flat water body would have greater vapor pressure than a concave surface, but less than a convex surface. One study indicated that evaporation is proportional to surface diameter and perimeter, as opposed to surface area, but quantifying equations were not available (Chow, 1964).

2.2 METHODS OF DETERMINING EVAPORATION

2.2.1 Evaporation Pans

Evaporation pans are the most widely used instrument for evaporation measurement. Pans can be of the sunken, floating, or surface types. Sunken pans eliminate boundary effects, such as radiation on the sidewalls and heat exchange between the pan and the atmosphere; however, they are difficult to install and leaks are difficult to detect. Splashing effects prevent floating pans from producing more accurate results than on-shore pans. Above-ground pans intercept some radiant energy and transfer sensible heat through the pan walls, resulting in the need to adjust the data. However, they are the easiest and most economical to install, and are therefore the type most frequently used (Linsley, Kohler, and Paulhus, 1958).

The U.S. Weather Bureau Class A Land Pan is the official pan for National Weather Service (NWS) stations. A standard Class A Pan is an unpainted 22-gage steel tank 4 feet in diameter and 10 inches deep. The bottom is supported on a wooden frame and raised 6 inches above the ground surface. It is filled with water to an exact depth. The water level is measured daily with a hook gage in a stilling well. If the pan is not shielded from precipitation, the daily total evaporation is the difference between observed levels, corrected for any precipitation measured in an adjacent or nearby standard rain gage. Without such correction for precipitation, the difference between observed levels is the net evaporation (Rohwer, 1931; Linsley, Kohler, and Paulhus, 1958; Chow, 1964).

Total pan evaporation may be correlated to shallow lake or reservoir evaporation by multiplying by a pan coefficient, usually between 0.6 and 0.82. Pan coefficients are lower in the winter months, although areas with mild winters show less variability from summer coefficients than stations subject to freezing temperatures. Pan coefficients also may vary by month due to instability of climatic conditions; consequently, pan coefficients tend to vary less during summer months than during spring and fall (Farnsworth and others, 1982). Pan coefficients vary from 0.64 to 0.88 for the May-through-October period (Chow, 1964). The "Climatic Atlas of the United States" (ESSA, 1983) contains a contour map of pan coefficients for the continental U.S. According to this map, the appropriate May-through-October pan coefficient for the RFP is approximately 0.74. However, "Evaporation from Seven Reservoirs in the Denver Water-Supply System" (Ficke and others, 1977) calculated 1972 and 1973 summer-month evaporative losses from Ralston and Gross Reservoirs (5 miles southwest and 9 miles northwest of the RFP, respectively) by mass-transfer equations and measurement from pans. The results indicated summer-month pan coefficients to be between 0.29 and 0.61. The annual pan coefficient is the average of the monthly pan coefficients. Typically, 0.70 is the annual pan coefficient of choice (Chow, 1964). For the purpose of calculating the area required for evaporation systems at the RFP, this surface-water evaporation study utilized only annual pan coefficients of 0.70 and 0.74 in converting pan evaporation to total evaporation because the long periods of record used to derive these coefficients makes them more reliable than those derived from the Ralston/Gross Reservoirs studies. These annual pan coefficients were used for monthly and annual total evaporation because reliable monthly pan coefficients were not found. If the actual RFP annual pan coefficient is closer to 0.29 and 0.61, rather than 0.70 or 0.74, then the actual RFP annual pan evaporation is less than that calculated in this study.

2.2.2 Water-Budget Determinations

To determine reservoir evaporation through a water budget or energy budget, it is necessary to measure water storage, surface inflow and outflow, subsurface seepage, and precipitation. Shortfalls of this method include the propagation of error with each measurement, difficulty in measuring seepage, and the ability of a lake to trap more blowing snow than is indicated by a rain gage (Linsley, Kohler, and Paulhus, 1958). Cherry Creek Dam reservoir evaporation was calculated by the Omaha District of the U.S. Army Corps of Engineers (COE) using this technique.

2.2.3 Dalton's Law Equations

Equations used in calculating evaporation are based on Dalton's law (of evaporation and vapor pressure) (Dalton, 1802). Generally, the various equations for calculating evaporation incorporate saturation vapor pressure corresponding to air temperature, actual vapor pressure, a multiplicative constant, and wind speed. Differences arise in the applicability of an equation to large water bodies compared to small water bodies, and in the measuring criteria for each factor. The Meyer equation was used in this study because it incorporates air temperature, dew point, and wind speed, all of which were available at the RFP.

The Meyer equation (Chow, 1964) is as follows:

$$E = C(E_w - E_a)(1 + 0.1W), \tag{1}$$

where E = Evaporation (inches/30 days)
C = Meyer equation constant, "Meyer C"
W = Monthly mean wind velocity at 30 feet above the ground (miles/hour)
E_w = Saturation vapor pressure corresponding to monthly mean air temperature for small bodies of shallow water (or water temperature for large, deep water bodies) (inches Hg)

$E_w = (0.0041T + 0.676)^8 - 0.000019|T + 16| + 0.001316$ (ASCE, 1974), (2)

where T = Air temperature (°F)

E_a = Actual vapor pressure based upon monthly mean air temperature and relative humidity for small, shallow water (or at 30 feet above water for large, deep water bodies) (inches Hg)

$E_a = (RH \times E_w)/100$ (Chow and others, 1988), (3)

where RH = Relative humidity (percent), or

$E_a = (0.0041T_{dew} + 0.676)^8 - 0.000019|T_{dew} + 16| + 0.001316$ (Chow, and others, 1988),

where T_{dew} = Dew point (°F)

The most sensitive (and therefore, most important) variable in the above Meyer equation is air temperature. It was discovered, as a result of a sensitivity analysis conducted during this study, that a 50-percent increase in air temperature alone produced approximately 3 times the rate of evaporation; whereas, independently multiplying wind speed and relative humidity by 1.5 produced approximately 1 and 0.5 times the evaporation rate, respectively.

According to Chow (1964), the value of C in the Meyer equation ranges from 11 for large, deep water bodies to 15 for small, shallow water bodies. These values of C correspond to monthly reservoir evaporation. Because the data used in this study were presented as monthly pan evaporation, the calculated Meyer C values are a factor of 1.35 or 1.43 higher than those to be used for the calculation of reservoir evaporation, depending on whether a pan coefficient of 0.74 or 0.70 is used, respectively.

3.0 REGIONAL TOTAL PAN EVAPORATION DATA SOURCES

3.1 NATIONAL WEATHER SERVICE OBSERVATION STATIONS

Total pan evaporation data were compiled from seven National Weather Service (NWS) observation stations in eastern Colorado. Although the NWS has 15 stations in Colorado that record pan evaporation, only 7 of these were west of the Rocky Mountains and at elevations less than 7,500 feet above mean sea level (and consequently judged to be meteorologically similar). The selected stations ranged from 30 to 230 miles in distance from the Rocky Flats Plant (RFP) (Figure 1). Generally, data were recorded from April through October, although some months are missing. Because the data did not encompass the winter months, annual pan evaporation could not be accurately determined. Consequently, the different stations were compared on a monthly basis (Appendix A). Table 1 provides a summary of the April-through-October average total pan evaporation for the seven NWS stations and indicates the years of record. The highest value of April-through-October total pan evaporation was 70.73 inches at Springfield 7 WSW; the lowest value was 38.80 inches at Fort Collins.

3.2 OTHER SOURCES OF EVAPORATION DATA

RFP pan evaporation measurements began in October 1990. As a result, only 27 days of data (taken in October and November 1990) were available for comparison as of this report. During these 27 days, total pan evaporation was estimated to be 4.31 inches. Because the regional NWS stations do not record pan evaporation from November through March, a comparison could not be made between this measured RFP value and those of regional stations.

Reservoir evaporation was compiled from the COE Cherry Creek Dam station for the years 1948 through 1983. Reservoir evaporation was calculated monthly, and therefore, served as a reference for annual reservoir evaporation. However, the calculations were derived from a reservoir water balance with evaporation and seepage as unknowns; therefore, it is likely that actual reservoir evaporation is less than that presented by the data (ASI, 1991). By using an annual pan coefficient of 0.70 (see Section 2.2.1), average monthly Cherry Creek Dam reservoir evaporation rates were converted to monthly pan evaporation rates. Table 1 includes Cherry Creek Dam April-through-October average total pan evaporation for comparison to the seven NWS stations.

In addition, average annual total reservoir evaporation for the years 1956 through 1970 is presented in "Evaporation Atlas for the Contiguous 48 United States," (Farnsworth and others, 1982) to be approximately 55 inches/year. A 29-year record (1931 through 1960) compiled in an EPA report (EPA, 1983) indicated that the total annual pan evaporation in the RFP area is approximately 65.35 inches.

Ficke and others (1977) presented results from a 1972-through-1973 study of evaporation from Gross and Ralston Reservoirs. Gross Reservoir is about 9 miles northwest of the RFP and Ralston Reservoir is about 5 miles southwest of the RFP (Figure 1). For each site, reservoir evaporation was calculated through mass-balances and pan evaporation was measured. The data obtained from Gross and Ralston Reservoirs were not used to estimate RFP evaporation because the length of record was judged to be too short to provide conclusive results. These data are presented below.

At Gross Reservoir during the June 29 through October 26, 1972 period (119 days), total reservoir evaporation was calculated to be 16.73 inches; pan evaporation was measured at 27.53 inches (indicating a pan coefficient of 0.61, as discussed in Section 2.2.1 of this report). During the period May 31 through October 18, 1973 (140 days), 22.82 and 40.44 inches for reservoir and pan evaporation, respectively were obtained (indicating a pan coefficient of 0.55).

At Ralston Reservoir during the period August 9 through October 25, 1972 (77 days), reservoir evaporation determined by mass balance was 5.91 inches; pan measurement was 20.19 inches (producing a pan coefficient of 0.29). May 30 through November 21, 1973 (175 days) indicated reservoir evaporation to be 25.31 inches; pan evaporation, 52.21 inches (corresponding to a pan coefficient of 0.48).

Table 1

Comparison of Average Total Pan Evaporation (April Through October) From the Seven NWS Locations and Cherry Creek Dam (Inches)

Station Name [1]	Distance (miles) and Direction From the RFP	Years of Record (Duration and Number)	Average Total Pan Evaporation
Pueblo WSO AP	120 SE	1971 - 1989 (19)	69.90
Pueblo Reservoir	120 SE	1975 - 1989 (15)	66.05
Springfield 7 WSW	230 SSE	1956 - 1989 (34)	70.73
Trinidad Lake	200 SSE	July - Oct., 1989 (1)	32.65
Akron 4 E	120 ENE	1972 - 1989 (18)	68.13
Bonny Lake/Bonny Dam	170 E	1953 - 1989 (28) [2]	67.39
Fort Collins	50 NNE	1953 - 1989 (37)	38.80
Cherry Creek Dam	30 SE	1948 - 1990 (43)	48.06 [3]

1) Station location shown on Figure 1.
2) No data recorded at Bonny Lake/Bonny Dam 1979 through 1987.
3) Cherry Creek Dam data were converted to pan evaporation by using a pan coefficient of 0.70.

4.0 CALCULATION OF ROCKY FLATS PLANT EVAPORATION

4.1 FREE-WATER SURFACE EVAPORATION

4.1.1 Estimation of Rocky Flats Plant Total Pan Evaporation

Of the seven selected regional National Weather Service (NWS) evaporation stations, that located at Fort Collins was judged to be geographically most similar to the Rocky Flats Plant (RFP). In addition, Fort Collins has the longest period of record of pan evaporation data (37 years). Consequently, Fort Collins data were selected for the calculation of RFP pan evaporation. Because the Fort Collins data did not include relative humidity, Denver WSFO-AP relative humidity was selected as the closest substitute. These relative humidity data were combined with Fort Collins air temperature, wind speed, and average monthly total pan evaporation to calculate monthly constants, C, in the Meyer equation (Equation 1). Although the wind speed at the Fort Collins station was measured at a height of 1.5 feet, it was determined to be unnecessary to adjust the wind speed to the height of 30 feet specified by the Meyer equation because wind speed does not significantly affect the value of C, as previously discussed in Section 2.2.3. In addition, as long as the RFP evaporation is calculated with RFP wind speeds adjusted to 1.5 feet, the value should be correct since C is a multiplicative factor. The resulting Meyer C values ranged from 14.65 in October to 24.35 in April. Multiplying these values by a pan coefficient of 0.70 yields 10.26 and 17.05, respectively, which compare favorably with the 11-to-15 range reported by Chow (1964). Table 2 contains the calculated average Meyer C values for the months of April through October. Meyer C calculations are detailed in Appendix B.

The calculated Fort Collins monthly average Meyer C's for April through October were used in conjunction with RFP observed air temperature, wind speed, and dew point to calculate on-site total pan evaporation. Although on-site meteorological data have been collected at the RFP for a number of years, only June 1989 through October 1989 and April 1990 through June 1990 monthly data were made available to ASI. A thesis on the surface-water flow mechanics of an

Table 2

Average Calculated Meyer C Values [1]
April Through October

Month	Meyer C
April	24.4
May	19.7
June	17.3
July	15.2
August	14.7
September	16.0
October	14.7

---

1) Calculated from Fort Collins total monthly pan evaporation, average monthly air temperature, and average monthly wind speed (1953 Through 1989), and Denver average monthly relative humidity.

RFP evaporation spray field (Koffer, 1989) contained 24-year monthly averages of relative humidity, air temperature, and wind speed at the RFP. Since the 13 months of wind speed were measured at a height of 10 meters (32.8 feet) above the ground and the 24-year average wind speeds were measured at 2 meters (6.6 feet) above the ground, the following equation (Linsley, Kohler, and Paulhus, 1958) was used to adjust the data to a height of 1.5 feet above the ground for use in the Meyer equation:

$$\frac{v}{v_o} = \left(\frac{z}{z_o}\right)^k, \tag{4}$$

where v = wind speed at 1.5 feet above the ground (miles/hour)
v_o = wind speed at 32.8 or 6.6 feet above the ground (miles/hour)
z = 1.5 feet
z_o = 32.8 or 6.6 feet
k = 1/7

The units of evaporation rate in the Meyer equation are inches/30 days; subsequently, results were converted to inches/month to accommodate months containing 31 days. Because the thesis data were 24-year averages for each month, only 24-year monthly average pan evaporation rates could be calculated. Such monthly averages do not illustrate long-term evaporation-rate trends; however, they are included in Table 3 for comparison along with corresponding Fort Collins 1989 and 1990 total pan evaporation and Fort Collins 1953 through 1989 monthly total pan evaporation averages. The 1990 Fort Collins data were obtained through personal communication with NWS and are not yet published; therefore, they are considered to be provisional. Consequently, the 1990 data were not used in the calculation of Meyer C values. RFP meteorological data and total pan evaporation calculations are included in Appendix C.

By comparing the 13 months of calculated RFP total monthly pan evaporation to the 37-year Fort Collins monthly averages, it was noted that the RFP evaporation rate was consistently greater (by approximately 45 percent) than the Fort Collins rate. Comparison between the April-through-October average meteorological factors of the two sites revealed that although air temperatures

Table 3

Calculated RFP Total Monthly Pan Evaporation and Corresponding Fort Collins Pan Evaporation (Inches)

Month	RFP (1989-1990)	Fort Collins	RFP (1952-1976) averages	Fort Collins (1953 - 1989) averages
June 1989	7.37	6.18	8.35	6.48
July 1989	12.06	8.44	8.80	7.24
August 1989	9.01	6.22	8.86	6.30
September 1989	8.04	4.73	6.22	4.90
October 1989	5.49	3.62	4.98	3.27
April 1990	5.24	4.06 [1]	5.72	4.95
May 1990	6.41	5.87 [1]	5.77	5.66
June 1990	12.97	8.19 [1]	8.35	6.48

1) 1990 Fort Collins evaporation data were not published at the time of report preparation; data shown were obtained through personal communication with NWS and are considered to be provisional.

were comparable (within 2 percent), wind speeds at the RFP were approximately 3 times greater than those at Fort Collins, and relative humidity was approximately 16 percent lower at the RFP. Detailed comparisons are included in Appendix D. A significant factor in this discrepancy between the two data sets is the length of record of the RFP data compared to that of the Fort Collins data. The RFP calculations incorporated only 13 months of data, and as such, the calculated monthly evaporation rates are not as reliable as those indicated by the 37-year long-term trend of the Fort Collins station. The use of long-term on-site data is essential in the calculation of reliable evaporation rates. When the 1952-through-1976 calculated RFP monthly average pan evaporation rates were compared to the 1953-through-1989 Fort Collins monthly average pan evaporation rates, the RFP evaporation was still greater (by approximately 25 percent). This may indicate that actual evaporation rates at the RFP are greater than those at Fort Collins. However, it should be noted that the 1952-through-1976 RFP monthly averages could not be verified by RFP personnel at the time of this report.

Cherry Creek Dam reservoir evaporation data were converted to pan data by assuming a pan coefficient of 0.70. The resulting annual total pan evaporation rate was 54.47 inches. Cherry Creek Dam average pan evaporation for the months November through March were used as approximations for estimating the missing months of RFP total pan evaporation. The resulting average annual total pan evaporation at the RFP was calculated to be 72.96 inches. The Fort Collins average annual total pan evaporation (using Cherry Creek Dam average monthly pan evaporation for the months of November through March) was calculated to be 45.22 inches.

Comparisons are made of the long-term trend of monthly total pan evaporation rates for Cherry Creek Dam, Fort Collins, and RFP (Figure 2); Pueblo WSO AP, Pueblo Reservoir, and RFP (Figure 3); Springfield 7 WSW, Trinidad Lake, and RFP (Figure 4); and Akron 4 E, Bonny Lake, and RFP (Figure 5). A table comparing discrete measurements from the seven NWS evaporation stations, Cherry Creek Dam, and RFP from January 1948 through December 1990 is given in Appendix E. Only the RFP evaporation calculated from the 13 months of data is represented because the 1952-through-1976 data consist only of 24-year averages for each month, and therefore do not illustrate a long-term trend.

4.1.2 Conversion to Net Reservoir Evaporation

Table 4 summarizes total and net reservoir evaporation calculations made in this study for the RFP and compares these calculations to measured and published data. Two values of RFP total annual reservoir evaporation were calculated by multiplying the sum of the monthly total pan evaporation by pan coefficients of 0.70 and 0.74 to produce 43.98 inches and 46.50 inches, respectively.

The RFP average annual precipitation for the years 1953 through 1976 (24 years) averages approximately 15.16 inches, although the 24-year record is missing several data points. This value was subtracted from the average total reservoir evaporation rates to produce 28.82 and 31.34 inches, respectively, of net evaporation at the RFP.

For comparison, net annual reservoir evaporation at Cherry Creek Dam was calculated by subtracting the annual average precipitation of 15.34 inches (for the years 1948 through 1990) from the average total annual reservoir evaporation of 38.13 (for the years 1948 through 1983). Because Cherry Creek Dam data were not pan data, no pan coefficients were involved. Consequently, only one value, 22.79 inches/year, was calculated as the net annual reservoir evaporation.

According to the "Evaporation Atlas for the Contiguous 48 United States" (Farnsworth and others, 1982), average total annual reservoir evaporation for the years 1956 through 1970 is 38.0 inches/year. The ESSA (1983) "Climatic Atlas of the United States" indicates average annual precipitation for the years 1946 through 1955 to be 16.0 inches/year, resulting in an estimated average annual net evaporation rate of 22.0 inches/year for the Rocky Flats area.

Table 4

Net Annual Reservoir Evaporation

Pan Coefficient	ROCKY FLATS [1] Calculated TOTAL RESERVOIR EVAPORATION (inches/year)	ROCKY FLATS 1953-1976 average TOTAL PRECIPITATION (inches/year)	ROCKY FLATS [2] NET RESERVOIR EVAPORATION (inches/year)
0.74	46.50	15.16	31.34
0.70	43.98	15.16	28.82

Pan Coefficient	CHERRY CREEK DAM 1948-1983 average TOTAL RESERVOIR EVAPORATION (inches/year)	CHERRY CREEK DAM 1948-1990 average TOTAL PRECIPITATION (inches/year)	CHERRY CREEK DAM NET RESERVOIR EVAPORATION (inches/year)
NA	38.13	15.34	22.79

Pan Coefficient	EVAPORATION ATLAS (Farnsworth and others, 1982) 1956-1970 average TOTAL RESERVOIR EVAPORATION (inches/year)	CLIMATIC ATLAS (ESSA, 1983) 1948-1990 average TOTAL PRECIPITATION (inches/year)	ATLAS' NET RESERVOIR EVAPORATION (inches/year)
NA	38.0	16.0	22.0

Pan Coefficient	FORT COLLINS [1] (Platte Drainage Basin) 1953-1989 average TOTAL RESERVOIR EVAPORATION (inches/year)	FORT COLLINS [1,3] Task 21 Operational Study 1953-1990 average TOTAL RESERVOIR EVAPORATION (inches/year)	CHERRY CREEK DAM 1948-1990 average TOTAL PRECIPITATION (inches/year)	TASK 21 Operational Study NET RESERVOIR EVAPORATION (inches/year)
0.74	33.20	33.05	15.34	17.71
0.70	31.65	31.26	15.34	15.92

1) Fort Collins and Rocky Flats total annual reservoir evaporation was calculated using Cherry Creek Dam data for November through March.
2) Actual Rocky Flats annual net reservoir evaporation will vary significantly from that presented here because this value was calculated with only 13 months of on-site evaporation data and 24 years of on-site precipitation data (plus 43 years of Cherry Creek Dam evaporation data for November through March).
3) Task 21 operational study (ASI, 1990) calculated Fort Collins total annual reservoir evaporation by using evaporation averages for several months in 1990.

For comparison, the Zero Discharge Task 21 operational study (ASI, 1991) evaporation rate is included. The Task 21 study derived 1953-through-1990 Fort Collins data by using average values for missing values, resulting in an annual total reservoir evaporation rate of 31.26 (using an annual pan coefficient of 0.70). The Task 21 operational study used Cherry Creek Dam average annual precipitation instead of RFP precipitation due to the greater number of years of monthly data. The resulting Task 21 net annual reservoir evaporation was 15.92 inches/year for the RFP, corresponding to an annual pan coefficient of 0.70. For comparison, a net annual reservoir evaporation rate of 17.72 inches/year was calculated for the RFP using an annual pan coefficient of 0.74 (see Section 2.2.1). This surface-water evaporation study also used RFP precipitation in the calculation of net reservoir evaporation because the RFP precipitation served as another reference and because its smaller magnitude provided a more conservative estimate of net evaporation for the evaporation pond sizing estimate.

The calculated RFP net annual reservoir evaporation is nearly twice that used in the Task 21 operational study (ASI, 1991) because the calculated RFP total annual pan evaporation rate is greater than that used for Task 21 (Fort Collins) due to higher wind speeds at the RFP, and because the RFP precipitation is less than that used for Task 21 (Cherry Creek Dam).

4.2 SPRAY EVAPORATION

Merrick & Company (1990) calculated the evaporation potential associated with a spray field. The evaporation potential was estimated in terms of the percentage of evaporation corresponding to given averages of droplet radius, monthly temperature, and relative humidity. The following discussion is taken from Merrick & Company (1990):

> To estimate the percentage of evaporation given the following parameters:
>
> | | |
> |---|---|
> | Average droplet radius | r |
> | Average monthly temperature | T |
> | Average relative humidity | RH |

Vapor pressure, e, can be defined by the equation $e = p_v R_v T$, (5)

where p_v = vapor density

R_v = individual gas constant for water vapor = 461 $J \cdot kg^{-1} K^{-1}$

Since the saturation vapor pressure, e_s, depends only upon temperature we can relate L (the latent heat of vaporization) to the saturation vapor pressure using

$$\frac{de_s}{dT} = L\frac{e_s}{R_v T^2} \tag{6}$$

If we assume the latent heat is constant we can integrate to obtain:

$$\ln\frac{e_s}{e_{so}} = \frac{L}{R_v}\left[\frac{1}{T_o} - \frac{1}{T}\right], \tag{7}$$

Where e_{so} is the value of saturation pressure at T_0.

$T_0 = 273°K$
given $L = 2.35 \times 10^6 J\ kg^{-1}$ at 64°
$T = 291°K$
$e_{so} = e_s \cdot RH/100$
$e_{so} = 8.684$

We can solve for e_s using

$$e_s = e_{so} \exp\left[\frac{L_v}{R_v}\left(\frac{1}{273} - \frac{1}{T}\right)\right] = 19.30 \tag{8}$$

Using the equation for droplet evaporation

$$r\frac{dr}{dt} = \frac{S-1}{[F_r + F_d]}, \text{ where } S = \frac{e_s}{e_{so}} = 0.45 \tag{9}$$

and F_r represents the thermodynamic term associated with heat conduction and F_d is the term associated with vapor diffusion (terms obtained from Figure 6.1, p. 70, <u>A Short Course in Cloud Physics</u>, R.R. Rogers, 1983)

$$r(t) = \left[r_o^2 + 2t\frac{S-1}{[F_r + F_d]}\right]^{\frac{1}{2}} \tag{10}$$

$F_r + F_d = 10^{5.93}$ at $T = 291°K$

given an initial radius of 0.00065 meters and monthly averages for June:

$T = 65°F = 291°K$
RH = 45 percent
droplet suspension time = 0.25 sec.

Then

$e_s = 8.684$
$e_{so} = 19.297$
$S = 0.45$

$$r(0.25) = \left[0.00065^2 + 2(0.25)\left(\frac{0.45-1}{10^{5.93}}\right)\right]^{\frac{1}{2}}$$

$r(0.25) = 0.00031$ meters

The volume of a sphere is given by

$$V = \frac{4}{3}\pi r^3 \tag{11}$$

$V_i = 1.15 \times 10^{-9} m^3$

$V_t = 1.23 \times 10^{-10} m^3$

Therefore the percentage of evaporation for an average drop in June is

$$\frac{1.15x10^{-9} - 1.23x10-10}{1.15x10^{-9}} \times 100 = 89.33 \textit{ percent}$$

Merrick & Company (1990) calculated percentages of spray evaporation for the remaining 11 months of the year using the above method. The resulting average annual evaporation due to spray was presented as 66.2 percent.

5.0 EVAPORATION POND SIZING

5.1 FREE-WATER SURFACE EVAPORATION POND

Fort Collins, climatic atlases, Cherry Creek Dam, and two Rocky Flats Plant (RFP) net annual evaporation rates (corresponding to the two annual pan coefficients of 0.70 and 0.74) were selected to provide a wide range of estimated net annual reservoir evaporation values for comparison in the sizing of a free-water surface evaporation pond. The net evaporation values ranged from 15.92 to 31.34 inches.

The average RFP sanitary treatment plant (STP) effluent flow rate for the period 1986 through 1990 was 237.5 acre-feet/year (ASI, 1991). The Zero-Discharge Task 21 operational study (ASI, 1991) determined that, from the 1.9 square-mile drainage basin, surface-water runoff was 125.3 acre-feet/year; runoff due to the 100-year, 72-hour storm event, 425 acre-feet/year; and groundwater, 10 acre-feet/year, resulting in a total flow rate of approximately 800 acre-feet/year. The RFP Surface Water Management Plan (EG&G, 1991) indicated that STP effluent, surface-water runoff, 100-year flood runoff, and groundwater flow rates from a 4 square-mile drainage basin were 280, 430, 260, and 10 acre-feet/year, respectively, resulting in approximately 1000 acre-feet/year of total flow that may be eligible for evaporative treatment. Flow rates of 250, 500, and 1000 acre-feet/year were selected for this study to bracket the above flow-rate scenarios in establishing a link between flow rate and resulting minimum pond area.

The depth of a typical evaporation pond was assumed to equal the corresponding net annual evaporation rate, because the annual change in water level would equal the net evaporation rate, regardless of pond surface area. Therefore, increasing the pond depth would not reduce the minimum required pond surface area, although it could protect against system overflow in the event of an unusually rainy season.

Results of the evaporation pond sizing for the selected flow rates are presented in Table 5. The maximum required pond area was approximately 754 acres, corresponding to a flow rate of 1000 acre-feet/year and an evaporation rate of 15.92 inches/year. The smallest pond area was approximately 96 acres, resulting from a flow rate of 250 acre-feet/year and an evaporation rate of 31.34 inches/year. For reference, the area available for an evaporation system encompasses approximately 1,193 acres north and west of the RFP Controlled Area.

5.2 SPRAY EVAPORATION POND

To calculate the pond area needed for a spray evaporation system, an evaporation percentage of 66.2 was applied to the three flow rates. This percentage is based upon the average annual percent evaporation of water droplets of 0.002-foot radius with a droplet fall time of 0.25 seconds for a fall distance of 1 foot (Merrick & Company, 1990). Although there would be some free-water surface evaporation from a spray pond system, it would be diminished by the decreased vapor pressure gradient resulting from the increased relative humidity at the air-water interface (ASI, 1991). Therefore, free-water surface evaporation was assumed to be negligible for the purpose of sizing a spray evaporation pond.

This method of calculating evaporation is dependent only upon the flow rate, so a pond depth must be selected to provide an estimate of the resulting pond area. Consequently, calculations using pond depths ranging from 5 to 35 feet were performed. The results are presented in Table 6. The minimum pond area was approximately 2 acres and corresponded to a flow rate of 250 acre-feet/year and a pond depth of 35 feet. The maximum pond area was approximately 68 acres and corresponded to a flow rate of 1,000 acre-feet/year and a pond depth of 5 feet.

The Task 21 operational study (ASI, 1991) contains preliminary cost estimates for spray evaporation and free-water surface evaporation ponds.

Table 5

Evaporation Pond Sizing For Free-Water Surface Evaporation

Flow Rate [1] (ac-ft/yr)	Source of Net Evaporation Data	Net Evaporation (in/yr)	Net Evaporation (ft/yr)	Resulting Minimum Pond Area[2,3] (ac)
250	Rocky Flats (Pan coefficient of 0.74)	31.34	2.61	96
250	Rocky Flats (Pan coefficient of 0.70)	28.82	2.40	104
250	Cherry Creek Dam	22.79	1.90	132
250	Climatic Atlases	22.0	1.83	136
250	Fort Collins (Task 21 Operational Study)	15.92	1.33	188
500	Rocky Flats (Pan coefficient of 0.74)	31.34	2.61	191
500	Rocky Flats (Pan coefficient of 0.70)	28.82	2.40	208
500	Cherry Creek Dam	22.79	1.90	263
500	Climatic Atlases	22.0	1.83	273
500	Fort Collins (Task 21 Operational Study)	15.92	1.33	377
1,000	Rocky Flats (Pan coefficient of 0.74)	31.34	2.61	383
1,000	Rocky Flats (Pan coefficient of 0.70)	28.82	2.40	416
1,000	Cherry Creek Dam	22.79	1.90	527
1,000	Climatic Atlases	22.0	1.83	545
1,000	Fort Collins (Task 21 Operational Study)	15.92	1.33	754

1) RFP Sanitary Treatment Plant (STP) effluent flow rate for the period 1986 through 1990 was 237.5 ac-ft/year (ASI, 1991).
2) Pond area calculation assumes a minimum pond depth of the associated annual evaporation.
3) Available area north and west of the Controlled Area is 1,193 acres.

Table 6

Evaporation Pond Sizing For Spray Evaporation

Flow Rate [1] (ac-ft/yr)	Assumed Pond Depth (ft)	Resulting Pond Area [2),3)] (ac)
250	5	17
250	10	8
250	15	6
250	20	4
250	25	3
250	30	3
250	35	2
500	5	34
500	10	17
500	15	11
500	20	8
500	25	7
500	30	6
500	35	5
1,000	5	68
1,000	10	34
1,000	15	23
1,000	20	17
1,000	25	14
1,000	30	11
1,000	35	10

1) Sanitary Treatment Plant (STP) effluent flow rate for the period 1986 through 1990 was 237.5 ac-ft/year.
2) Merrick & Company (1990). Annual average droplet evaporation is 66.2 percent, assuming droplet radius = 0.002 ft, sprinkler height = 1 ft, droplet fall time = 0.25 sec.
3) Available area north and west of the Controlled Area is 1,193 acres.

6.0 PRELIMINARY ENVIRONMENTAL ANALYSIS

A critical environmental concern associated with an evaporation system is the possibility of pollutants entering the system and becoming airborne through evaporation. Airborne pollutants may increase the exposure of the down-wind off-site population. The probability of the formation of airborne pollutants is relatively minor with the use of free-water surface evaporation because the concentration of pollutants may be much lower in the vapor than in the remaining liquid due to differences in volatility between the water and the pollutants. The probability of airborne pollutant formation is much more critical in the use of spray evaporation due to the formation of aerosols. Such aerosol droplets contain the same concentration of pollutants as the liquid because the separation is achieved mechanically rather than through differences of volatility.

The possibility also exists for water releases through over-land flow due to system overload resulting from an inflow rate greater than the evaporation rate. Such over-land flow may result in contact with off-site surface waters. In addition, the evaporation pond may leak, possibly resulting in percolation to ground water.

7.0 ACKNOWLEDGEMENTS

This study was conducted by Advanced Sciences, Inc. (ASI), under the general supervision of Mr. Michael G. Waltermire, P.E., Project Manager, ASI. This report was written by Ms. Cynthia Kyle-Fischer, ASI Engineer with assistance from Dr. James R. Kunkel, P.E., P.H., ASI Senior Scientist. Other people that contributed to this report include Mr. Ralph Porter, EG&G - Environmental Restoration Department, Air Programs Group, and Mr. Frank J. Blaha, Doty & Associates. This report was reviewed by Dr. Timothy D. Steele, P.H., Manager, Physical Sciences Group, ASI; Mr. Michael G. Waltermire, P.E., Project Manager, ASI; and Mr. Frank J. Blaha, Doty & Associates.

EG&G and DOE responsive reviewers of this report included:

R.A. Applehans, EG&G - FE/PCSE
A. McLean, EG&G - ER/NEPA

This report was prepared and submitted in partial fulfillment of the Zero-Offsite Water-Discharge Study being conducted by ASI on behalf of EG&G Rocky Flats, Inc. EG&G's Project Engineer for this study was Mr. R.A. Applehans of EG&G's Facilities Engineering, Plant Civil-Structural Engineering (FE-PCSE).

8.0 REFERENCES

Advanced Sciences, Inc. (ASI), 1990, Surface-Water Evaporation Study Project Management Plan, Task 15 of the Zero-Offsite Water-Discharge Study: Prepared for EG&G Rocky Flats, Inc., Project No. 208.0115: August 29, 7 p., 4 appendices.

Advanced Sciences, Inc. (ASI), 1991, Temporary Water Storage Capabilities Study, Task 21 of the Zero-Offsite Water-Discharge Study: Prepared for EG&G Rocky Flats, Inc., Project No. 208.0121: March 19, 120 p., 3 appendices.

American Society of Civil Engineers (ASCE), 1974, Consumptive Use of Water and Irrigation Water Requirements, New York, 215 p.

Chow, V.T., 1964, Handbook of Applied Hydrology: A Compendium of Water-Resources Technology, McGraw-Hill Book Company, Inc., New York, section 11.

Chow, V.T., Maidment, D.R., and Mays, L.W., 1988, Applied Hydrology, McGraw-Hill Book Company, Inc., New York, 572 p.

Dalton, J., 1802, Experimental Essays on Evaporation, Manchester Lit. Phil. Soc. Mem. Proc., vol. 5, pp. 536-602.

EG&G, 1991, Draft Rocky Flats Surface Water Management Plan: Prepared for DOE, March, chapter 8.

Environmental Science Services Administration (ESSA), 1983, Climatic Atlas of the United States: U.S. Department of Commerce, Environmental Data Service, June, 1968, Washington, D.C., 80 p.

Farnsworth, R.K., Thompson, E.S., and Peck, E.L., 1982, Evaporation Atlas for the Contiguous 48 United States: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Report NWS 33, Office of Hydrology, National Weather Service, Washington, D.C., June, 26 p., 4 maps.

Ficke, J.F., Adams, D.B., and Danielson, T.W., 1977, Evaporation from Seven Reservoirs in the Denver Water-Supply System, Central Colorado, Water-Resources Investigations 76-114, USGS, 170 p.

Koffer, J.P., 1989, Investigation of the Surface and Groundwater Flow Mechanics of an Evaporative Spray Field at the Rocky Flats Nuclear Weapons Plant, Jefferson County, Colorado, Engineering Report for the Degree of Master of Engineering, Colorado School of Mines, August 23, 81 p.

Kohler, M.A., Nordenson, T.J., and Fox, W.E., 1955, Evaporation From Pans and Lakes, Research Paper 38, U.S. Department of Commerce, Weather Bureau, Washington, D.C., 21 p.

Linsley, R.K., Jr., Kohler, M.A., and Paulhus, J.L.H., 1958, Hydrology for Engineers, McGraw-Hill Book Company, Inc., New York.

Merrick & Company, 1990, Scope and Estimate for Re-Cycle Pond B-5 and A-4: Authorization No. 402079, BA No. 73607 HJ, Submitted to Facilities Engineering Department, EG&G, July.

National Oceanographic and Atmospheric Administration (NOAA), 1990, Climatological Data Monthly Summaries, Colorado: Fort Collins Station Data.

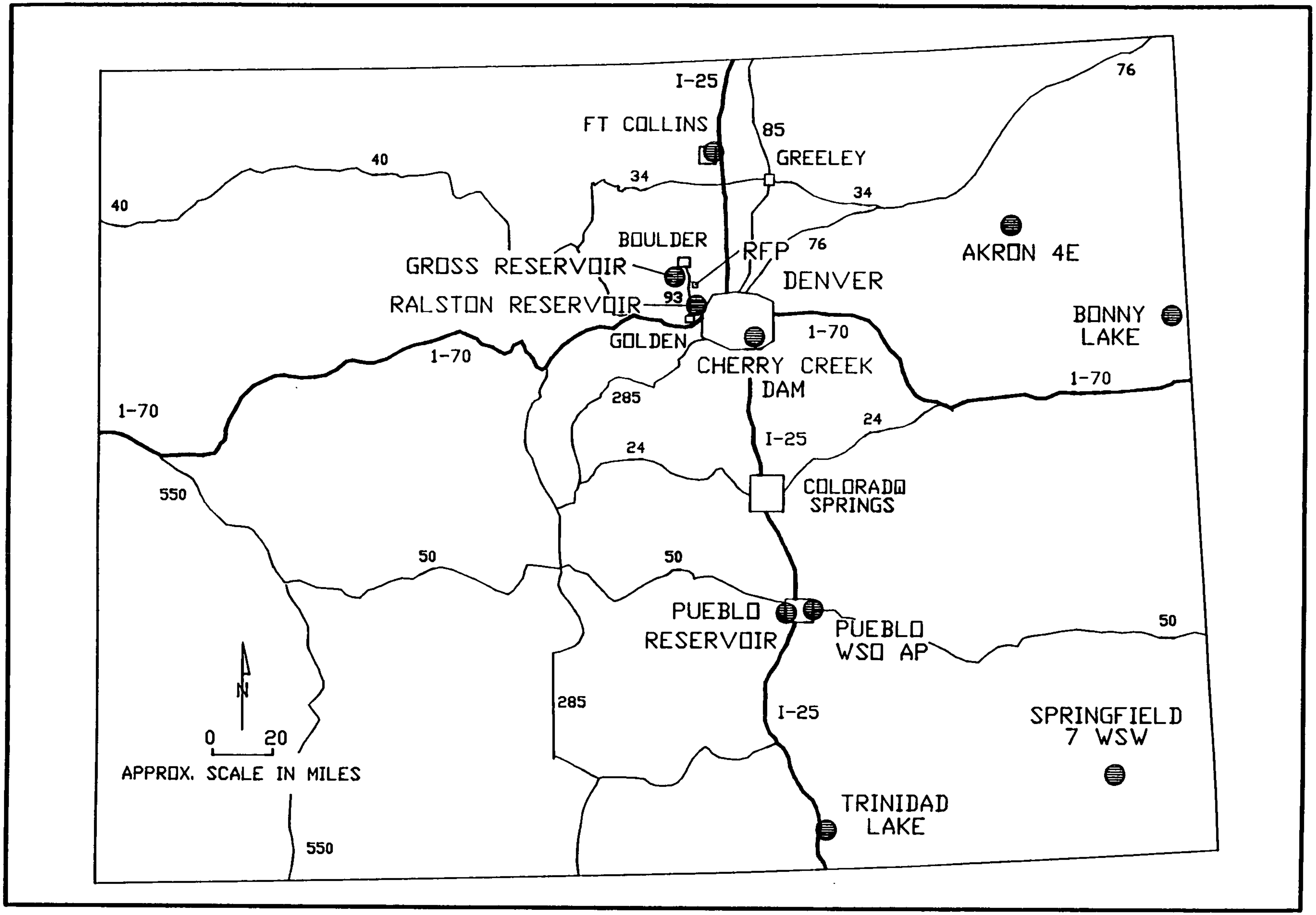
Rohwer, C., 1931, Evaporation From Free Water Surfaces, Technical Bulletin No. 271, U.S. Department of Agriculture, in Cooperation With Colorado Agricultural Experiment Station, Washington, D.C., 96 p.

U.S. Army Corps of Engineers (COE), Omaha District, 1990, Climatological Data Monthly Summaries, Colorado: Cherry Creek Dam Data.

U.S. Department of Energy (DOE) and State of Colorado, 1989, Agreement in Principle Between the United States Department of Energy and the State of Colorado: June 28, 25 p.

U.S. Environmental Protection Agency (EPA), 1983, Hazardous Waste Land Treatment, SW-874, Municipal Environmental Research Laboratory, Office of Research and Development, Cincinnati, Ohio, April, chapter 8.

FIGURES

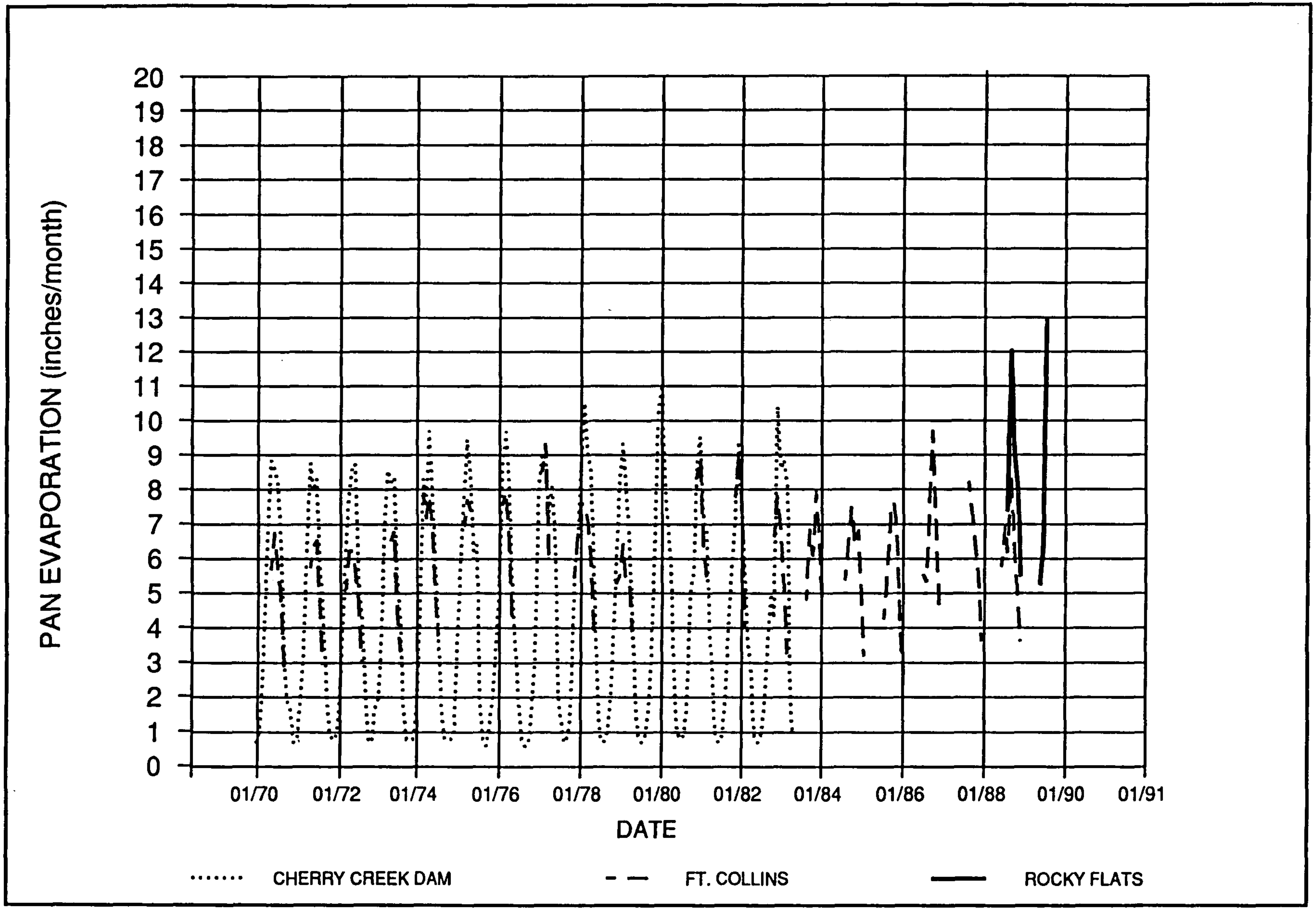


LOCATION OF EVAPORATION STATIONS

SURFACE-WATER EVAPORATION STUDY
ZERO-OFFSITE WATER DISCHARGE

PROJECT 208.01.15

FIGURE NO. 1

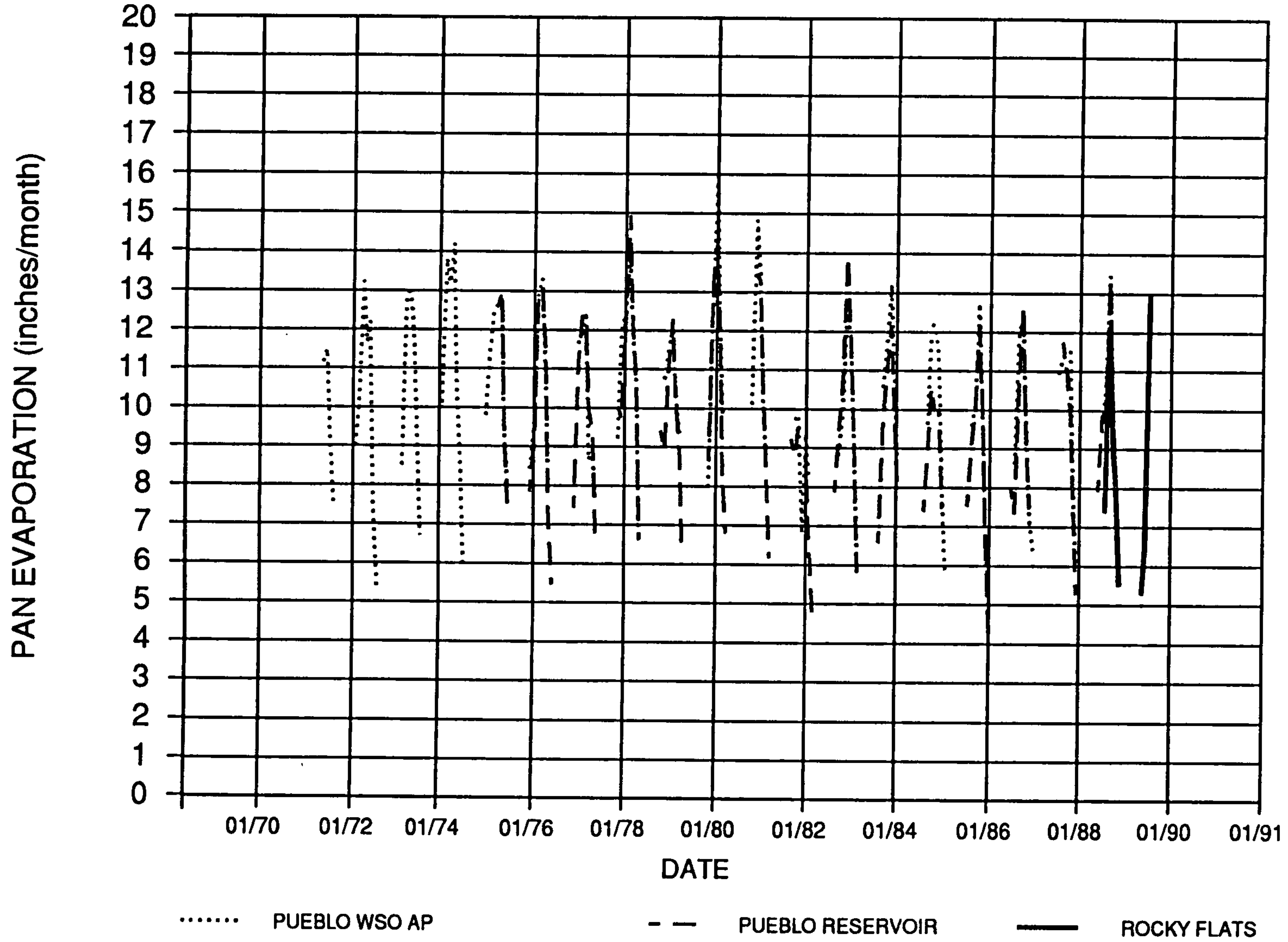


COMPARISON OF TOTAL PAN EVAPORATION

SURFACE-WATER EVAPORATION STUDY
ZERO-OFFSITE WATER DISCHARGE

PROJECT NO. 208.0115

FIGURE NO. 2

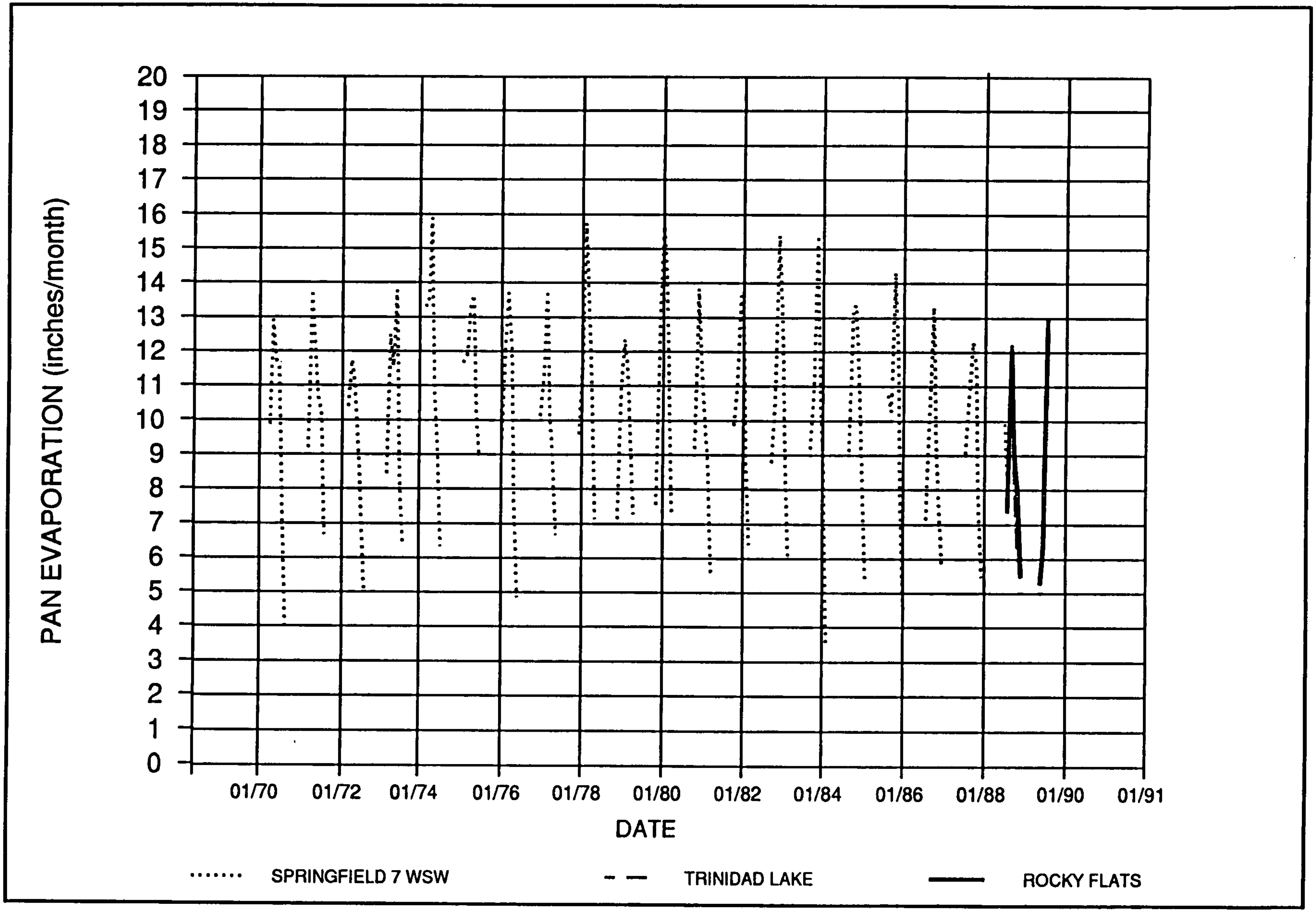


COMPARISON OF TOTAL PAN EVAPORATION

SURFACE-WATER EVAPORATION STUDY
ZERO-OFFSITE WATER DISCHARGE

PROJECT NO. 208.0115

FIGURE NO. 3

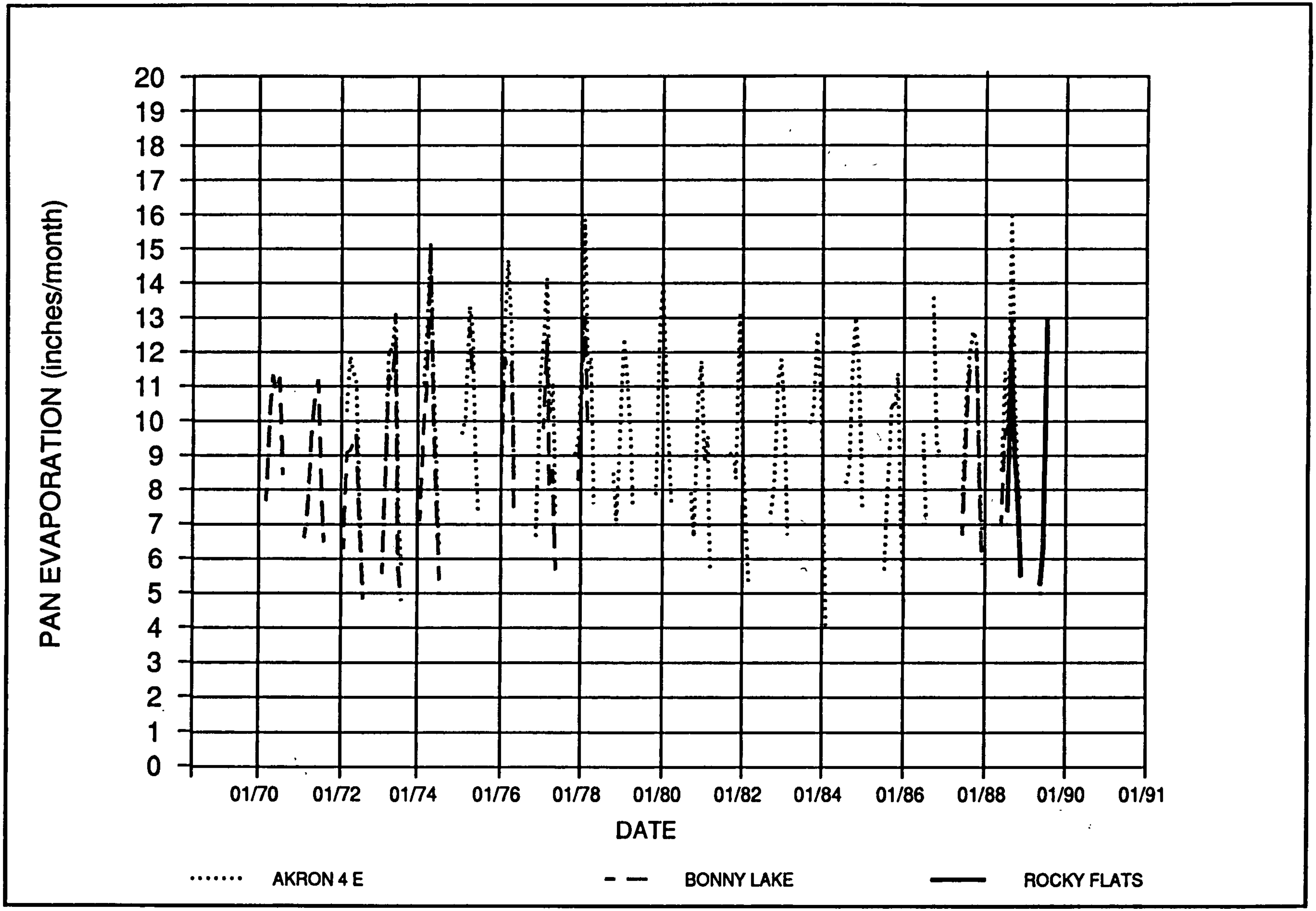


COMPARISON OF TOTAL PAN EVAPORATION

SURFACE-WATER EVAPORATION STUDY
ZERO-OFFSITE WATER DISCHARGE

PROJECT NO. 208.0115

FIGURE NO. 4



COMPARISON OF TOTAL PAN EVAPORATION

SURFACE-WATER EVAPORATION STUDY
ZERO-OFFSITE WATER DISCHARGE

PROJECT NO. 208.0115

FIGURE NO. 5

A

APPENDIX A

COMPARISON OF MONTHLY TOTAL PAN EVAPORATION (APRIL THROUGH OCTOBER)

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (April-October, 1948-1990)

APRIL

	FT. COLLINS (Larimer Co.) (EL=5004' MSL) (Platte D.B.) (in./30 days)	PUEBLO WSO AP (Pueblo) (EL=4684) (Ark. D.B.) (in./30 days)	PUEBLO RES. (Pueblo) (EL=4555) (Ark. D.B.) (in./30 days)	SPRINGFIELD 7 WSW (Baca) (EL=4580) (Ark. D.B.) (in./30 days)	TRINIDAD LAKE (Las Animas) (EL=6120) (Ark. D.B.) (in./30 days)	AKRON 4 E (Washington) (EL=4540) (Kansas D.B) (in./30 days)	BONNY LAKE (Yuma) (EL=3748) (Kansas D.B.) (in./30 days)	CHERRY CREEK DAM Reservoir E (Arapahoe) (EL=5646) Converted to (in./30 days)	ROCKY FLATS (Jefferson) (EL=~6100) Calculated (in./30 days)
1948								4.57	
1949								4.03	
1950								4.17	
1951								3.83	
1952								4.01	
1953	3.17							3.81	
1954	6.48						11.03	4.84	
1955	6.92						11.13	5.10	
1956	4.22						7.47	4.20	
1957	2.71							3.50	
1958	4.28						5.98	4.01	
1959	4.72						7.73	4.23	
1960	5.39						8.62	4.60	
1961	4.26						6.9	4.03	
1962							8.75	4.33	
1963							10.18	4.76	
1964								4.14	
1965							7.93	4.26	
1966							5.92	3.90	
1967	5.53						9.51	4.17	
1968								5.34	
1969							7.69	5.70	
1970							7.69	4.50	
1971							6.62	3.50	
1972		8.99					6.29	3.80	
1973							5.57	3.50	
1974		10.1					7.1	4.00	
1975		9.81						3.50	
1976		8.38	7.81					3.60	
1977			7.4			6.65		3.10	
1978	5.51	9.2	9.99			9.04		5.59	
1979			9.39			8.49		3.20	
1980								3.20	
1981			8.93			7.92		5.14	
1982			9.19			9.05		4.00	
1983			7.85					3.20	
1984	4.81		6.56						
1985	5.38		7.37			8.2			
1986	4.26		7.48			5.68			
1987	5.54		8.01			9.65			
1988	5.14		7.59			7.83	6.7		
1989	5.77		7.89			8.56	6.97		
1990									5.24
MEAN	4.95	9.30	8.11			8.11	7.79	4.15	5.24
VARIANCE	1.16	0.46	0.95			1.40	2.66	0.44	0.00
STD DEV	1.08	0.68	0.97			1.18	1.63	0.67	0.00

COMPARI[illegible] OF TOTAL MONTHLY PAN EVAPORATION (April-October, 19[illegible]990)
MAY

	FT. COLLINS (Larimer Co.) (EL=5004' MSL) (Platte D.B.) (in./30 days)	PUEBLO WSO AP (Pueblo) (EL=4684) (Ark. D.B.) (in./30 days)	PUEBLO RES. (Pueblo) (EL=4555) (Ark. D.B.) (in./30 days)	SPRINGFIELD 7 WSW (Baca) (EL=4580) (Ark. D.B.) (in./30 days)	TRINIDAD LAKE (Las Animas) (EL=6120) (Ark. D.B.) (in./30 days)	AKRON 4 E (Washington) (EL=4540) (Kansas D.B) (in./30 days)	BONNY LAKE (Yuma) (EL=3748) (Kansas D.B.) (in./30 days)	CHERRY CREEK DAM Reservoir E (Arapahoe) (EL=5646) Converted to (in./30 days)	ROCKY FLATS (Jefferson) (EL=~6100) Calculated (in./30 days)
1948								6.71	
1949								6.29	
1950								6.63	
1951								6.81	
1952								6.30	
1953	5.53						9.77	7.00	
1954	5.69						8.49	7.09	
1955	7.69						12.1	7.97	
1956	5.19						10.75	7.31	
1957	4.92			8.98			7.41	6.07	
1958	5.08			9.94			8.75	6.89	
1959	4.91			11.55			8.18	6.50	
1960	5.17			10.87			9.5	7.36	
1961	4.56			11.11			7.68	5.53	
1962	5.37			14.03			12.3	7.70	
1963	5.17			13.9			10.25	7.94	
1964	5.86			13.06			11.18	7.54	
1965	4.16			12.33			10.94	6.87	
1966	6.12			11.91			10.69	7.94	
1967	3.97			9.47			7.16	5.49	
1968				8.91			8.42	6.50	
1969				8.57			8.58	6.31	
1970				9.87			10.34	7.20	
1971				9.16			7.49	6.70	
1972	5.13	10.31		10.42		10.28	9.09	6.60	
1973		8.51		8.44		8.85	8.16	6.80	
1974	7.92	13.76		13.32		11.08	9.99	8.31	
1975		11.42		11.68		9.63	9.09	5.99	
1976		9.66	9.17	9.45		10.41	9	5.86	
1977		11.63	11.16	10.11		11.17		8.06	
1978	6.75	12.22	9.68	9.56		9.44	8.28	6.69	
1979	5.28	10.72	8.89	7.15		7.1		6.00	
1980		7.96	8.64	7.55		7.86		6.74	
1981		10.11		9.18		6.64		5.46	
1982		9.7	8.75	9.86		9.12		5.91	
1983		8.81	9.37	8.78		7.31		5.00	
1984	6.84	10.56	9.73	9.18		9.93			
1985	6.64	9.59	8.77	9.15		8.58			
1986	5.57	9.54	9.12	10.76		8.26			
1987	5.34	8.58	7.34	7.14		7.15			
1988		10.92		9.08		10.67	9.97		
1989	6.98	9.4	9.86	9.95		11.43	9.77		
1990									6.41
MEAN	5.66	10.19	9.21	10.13		9.16	9.38	6.72	6.41
VARIANCE	1.04	2.10	0.83	3.22		2.34	1.94	0.65	0.00
STD DEV	1.02	1.45	0.91	1.80		1.53	1.39	0.81	0.00

COMPAR[illegible] OF TOTAL MONTHLY PAN EVAPORATION (April-October, 19[illegible]990)
JUNE

	FT. COLLINS (Larimer Co.) (EL=5004' MSL) (Platte D.B.) (in./30 days)	PUEBLO WSO AP (Pueblo) (EL=4684) (Ark. D.B.) (in./30 days)	PUEBLO RES. (Pueblo) (EL=4555) (Ark. D.B.) (in./30 days)	SPRINGFIELD 7 WSW (Baca) (EL=4580) (Ark. D.B.) (in./30 days)	TRINIDAD LAKE (Las Animas) (EL=6120) (Ark. D.B.) (in./30 days)	AKRON 4 E (Washington) (EL=4540) (Kansas D.B) (in./30 days)	BONNY LAKE (Yuma) (EL=3748) (Kansas D.B.) (in./30 days)	CHERRY CREEK DAM Reservoir E (Arapahoe) (EL=5646) Converted to (in./30 days)	ROCKY FLATS (Jefferson) (EL=~6100) Calculated (in./30 days)
1948								7.81	
1949								7.56	
1950								8.71	
1951								7.47	
1952								9.41	
1953	6.73						14.43	8.86	
1954	8.35						16.76	9.59	
1955	5.28						10.5	8.31	
1956	7.95						15.92	9.74	
1957	6.33			11.22			8.63	8.60	
1958	6.52			12.46			11.13	8.11	
1959	6.14			12.21			13.44	8.99	
1960	7.15			12.48			9.48	8.70	
1961	4.78			12.3			10.55	8.09	
1962	4.94			11.89			10.59	8.26	
1963	6.16			15.99			15.79	8.46	
1964	5.14			14.01			11.44	7.87	
1965	4.39			10.85			9.58	7.23	
1966	6.04			13.43			11.88	8.00	
1967	2.81			9.53			7.76	6.09	
1968	6.52			13.89			13.52	9.40	
1969	4.68			9.17			9.74	6.57	
1970	5.69			12.87			11.33	8.84	
1971	5.74			13.77			9.72	8.77	
1972	6.25	13.21		11.78		11.88	9.16	7.94	
1973		12.67		12.48		12.09	11.33	8.57	
1974	7.16	13.14		13.38		12.75	10.86	7.50	
1975	6.96	12.47		11.79		10.16		7.89	
1976	7.56	12.94	12.86	12.34		12.94	11.86	8.80	
1977	8.53	11.9	12.35	11.23		12.38	9.78	9.04	
1978	7.58	12.25	12.34	11.8		11.97	10.91	8.76	
1979	5.50	11.49	11.06	10.96		9.97		8.20	
1980		12.75	13.34	12.85		12.74		10.33	
1981	8.35	14.82	13.43	13.83		10.61		8.71	
1982	7.78	9.83	9.64	11		8.33		7.26	
1983	6.63	9.79	10.58	10.58		8.12		4.29	
1984	6.08	11.61	10.89	10.91		10.42			
1985	7.49	12.16	10.56	13.25		11.62			
1986	7.45	10.16	10	10.29		10.54			
1987	7.63	11.93	10.51	9.7					
1988	8.24	11.35	11.71	10.67		11.96	11.5		
1989	6.18	10.4	9.53	8.18		9.72	9.61		7.37
1990									12.97
MEAN	6.48	11.94	11.34	11.91		11.07	11.39	8.24	10.17
VARIANCE	1.69	1.72	1.77	2.63		2.21	5.11	1.21	15.68
STD DEV	1.30	1.31	1.33	1.62		1.49	2.26	1.10	3.96

COMPAF OF TOTAL MONTHLY PAN EVAPORATION (April-October, 19[illegible]990)

JULY

	FT. COLLINS (Larimer Co.) (EL=5004' MSL) (Platte D.B.) (in./30 days)	PUEBLO WSO AP (Pueblo) (EL=4684) (Ark. D.B.) (in./30 days)	PUEBLO RES. (Pueblo) (EL=4555) (Ark. D.B.) (in./30 days)	SPRINGFIELD 7 WSW (Baca) (EL=4580) (Ark. D.B.) (in./30 days)	TRINIDAD LAKE (Las Animas) (EL=6120) (Ark. D.B.) (in./30 days)	AKRON 4 E (Washington) (EL=4540) (Kansas D.B) (in./30 days)	BONNY LAKE (Yuma) (EL=3748) (Kansas D.B.) (in./30 days)	CHERRY CREEK DAM Reservoir E (Arapahoe) (EL=5646) Converted to (in./30 days)	ROCKY FLATS (Jefferson) (EL=~6100) Calculated (in./30 days)
1948								9.74	
1949								8.33	
1950								8.29	
1951								9.10	
1952								10.06	
1953	6.96						14.84	9.01	
1954	8.95						17.16	9.79	
1955	8.71						16.69	10.57	
1956	7.66						12.69	9.71	
1957	7.13			13.42			11.6	9.01	
1958	6.14			11.38			9.17	8.34	
1959	7.26			14.68			14.46	10.71	
1960	7.65			13.82			13.09	9.89	
1961	5.46			13.24			12.37	8.76	
1962	5.61			12.87			11.89	9.31	
1963	6.99			17.28			15.62	9.64	
1964	6.34			15.44			15.57	10.33	
1965	5.56			12.35			11.64	7.94	
1966	7.12			13.35			13.25	9.01	
1967	4.23			9.85			9.62	6.63	
1968	6.3			12.66			11.21	9.89	
1969	6.60			11.41			12.27	7.81	
1970	6.76			11.72			10.85	8.60	
1971	6.35	11.15		11.95			10.65	7.97	
1972	6.20	11.64		11.09		11.43	9.37	8.74	
1973	6.51	13.05		11.53		12.03	11.15	8.21	
1974	7.84	14.19		15.86		15.21	15.17	9.70	
1975	7.72	12.61	12.56	13.26		13.34	12.72	9.46	
1976	7.95	13.27	13.05	13.72		14.7	11.45	9.69	
1977	9.34	12.42	11.95	13.8		14.13	12.37	8.93	
1978	7.63	14.01	14.9	15.71		15.87	13.02	10.54	
1979	6.45	12.02	12.27	12.35		12.4		9.33	
1980		15.93	14.18	15.67		14.33		11.06	
1981	8.9	13.39	13.22	11.55		11.74		9.53	
1982	9.1	6.80		13.61		13.17		9.40	
1983	7.82	12.42	13.93	15.4		11.18		10.40	
1984	7.97	13.18	12.12	15.38		12.62			
1985	6.37	12.14	9.98	13.37		13.02			
1986	7.64	12.71	12.06	14.3		10.39			
1987	9.72	12.37	12.66	13.32		13.59			
1988	7.32	11.40	11.08	12.31		12.61			
1989	8.44	13.40	13.27	11.87	12.22	15.95	12.87		12.06
1990									
MEAN	7.24	12.53	12.66	13.32	12.22	13.21	12.69	9.26	12.06
VARIANCE	1.46	3.14	1.60	2.84	0.00	2.54	4.51	0.90	0.00
STD DEV	1.21	1.77	1.26	1.69	0.00	1.60	2.12	0.95	0.00

COMPAF OF TOTAL MONTHLY PAN EVAPORATION (April-October, 19 990)

AUGUST

	FT. COLLINS (Larimer Co.) (EL=5004' MSL) (Platte D.B.) (in./30 days)	PUEBLO WSO AP (Pueblo) (EL=4684) (Ark. D.B.) (in./30 days)	PUEBLO RES. (Pueblo) (EL=4555) (Ark. D.B.) (in./30 days)	SPRINGFIELD 7 WSW (Baca) (EL=4580) (Ark. D.B.) (in./30 days)	TRINIDAD LAKE (Las Animas) (EL=6120) (Ark. D.B.) (in./30 days)	AKRON 4 E (Washington) (EL=4540) (Kansas D.B) (in./30 days)	BONNY LAKE (Yuma) (EL=3748) (Kansas D.B.) (in./30 days)	CHERRY CREEK DAM Reservoir E (Arapahoe) (EL=5646) Converted to (in./30 days)	ROCKY FLATS (Jefferson) (EL=~6100) Calculated (in./30 days)
1948								8.36	
1949								8.24	
1950								8.41	
1951								8.03	
1952								8.14	
1953	6.68						11.94	8.13	
1954	7.2						13.39	8.34	
1955	6.16						14.86	7.94	
1956	6.06						10.58	8.21	
1957	6.14			11.55			11.24	7.99	
1958	7.11			11.88			10.62	8.31	
1959	6.43			11.89			13.45	8.34	
1960	8.15			16.03			14.46	8.56	
1961	5.07			11.18			10.9	7.87	
1962	5.33			15.17			11.03	8.56	
1963	4.41			12.96			12.26	7.47	
1964	5.99			13.65			13.77	8.57	
1965	5.48			10.13			9.19	7.94	
1966	6.44			10.3			10.33	7.93	
1967	5.14			9.45			11.02	7.99	
1968	5.76			10.65			9.78	7.21	
1969	6.60			11.66			10.5	8.64	
1970	5.78			11.52			11.26	8.20	
1971	6.54	11.44		10.54			11.18	8.31	
1972	5.67	12.15		9.61		11.18	9.63	8.70	
1973	6.83	11.97		13.78		13.11	12.33	8.34	
1974	6.74	10.37		10.74		11.37	10.19	7.89	
1975	7.40	12.61	12.95	13.62		12.63	11.16	8.33	
1976	6.08	10.98	11.47	12.02		12.7	11.65	7.71	
1977	6.06	8.59	9.85	10.21		10.2	8.11	7.34	
1978	7.04	11.94	12.17	13.35		11.47	9.66	8.96	
1979	5.26	10.28	10.08	11.39		11.41		7.97	
1980		12.4	11.97	14.18		11.77		8.46	
1981	6.24	9.93	10.37	10.01		8.83		7.17	
1982	7.55	9.33	8.79	12.79		9.38		7.29	
1983	6.80	11.86	11.76	13.3		11.8		8.59	
1984	6.41	10.72	9.83	10.42		10.98			
1985	6.83	11.37	9.95	11.23		11.55			
1986	6.39	9.97	9.97	11.89		11.4			
1987	6.50	9.62	9.12	9.33		9.4			
1988	6.33	11.48	10.06	11.63		12.3	12.11		
1989	6.22	10.01	10.02	9.38	8.55	11.21	9.08		9.01
1990									
MEAN	6.30	10.90	10.56	11.74	8.55	11.26	11.27	8.12	9.01
VARIANCE	0.57	1.30	1.45	2.89	0.00	1.37	2.68	0.19	0.00
STD DEV	0.76	1.14	1.21	1.70	0.00	1.17	1.64	0.43	0.00

COMPAF OF TOTAL MONTHLY PAN EVAPORATION (April-October, 19[illegible]990)

SEPTEMBE.

	FT. COLLINS (Larimer Co.) (EL=5004' MSL) (Platte D.B.) (in./30 days)	PUEBLO WSO AP (Pueblo) (EL=4684) (Ark. D.B.) (in./30 days)	PUEBLO RES. (Pueblo) (EL=4555) (Ark. D.B.) (in./30 days)	SPRINGFIELD 7 WSW (Baca) (EL=4580) (Ark. D.B.) (in./30 days)	TRINIDAD LAKE (Las Animas) (EL=6120) (Ark. D.B.) (in./30 days)	AKRON 4 E (Washington) (EL=4540) (Kansas D.B) (in./30 days)	BONNY LAKE (Yuma) (EL=3748) (Kansas D.B.) (in./30 days)	CHERRY CREEK DAM Reservoir E (Arapahoe) (EL=5646) Converted to (in./30 days)	ROCKY FLATS (Jefferson) (EL=~6100) Calculated (in./30 days)
1948								7.29	
1949								6.59	
1950								5.26	
1951								6.40	
1952								7.36	
1953	6.61						11.83	8.13	
1954	5.63						12.07	6.90	
1955	5.44						10.35	6.70	
1956	6.21			13.43			10.94	8.00	
1957	5.06			9.56			7.81	6.76	
1958	5.45			10.61			9.39	6.90	
1959	4.97			11.22			10.64	7.11	
1960	5.93			10.33			9.75	6.94	
1961	3.19			9.29			7.61	5.14	
1962	4.45			8.49			7.22	6.34	
1963	4.5			9.65			7.73	5.60	
1964	4.46			9.33			9.71	6.90	
1965	3.75			7.13			4.74	4.89	
1966	4.7			7.58			8.68	5.91	
1967	3.54			7.66			8.26	6.21	
1968	4.57			9.52			8.26	6.10	
1969	5.00			6.77			6.79	5.74	
1970	4.70			7.79			8.44	6.31	
1971	4.76	9.19		10.24			8.57	6.03	
1972	4.66	7.57		8.04		8.16	7.39	5.26	
1973	4.47	9.21		8.32		7.63	5.7	5.37	
1974	4.67	8.58		8.76		8.74	7.73	5.69	
1975		9.25	9.17	10.18		9.06		6.23	
1976	4.22	7.89	7.41	7.76		8.38	7.5	5.40	
1977	6.24	8.89	9.44	8.76		11.13	8.6	8.16	
1978	6.07	10.85	10.55	10.55		11.87		8.64	
1979	5.27	9.33	8.99	9.14		9.75		6.49	
1980		9.74	8.37	10.3		9.47		7.04	
1981	5.49	8.8	8.15	8.7		9.56		6.74	
1982	3.98	8.19	6.57	8.88		7.63		5.79	
1983	5.41	9.52	9.55	9.71		10.4		8.86	
1984	4.67	8.65	8.15	9.07		8.15			
1985	4.70	7.82	7.47	8.23		7.46			
1986	4.03	6.78	6.59	7.44		7.1			
1987	4.53	7.24	7.46	7.57		9.01			
1988	5.61	8.21	7.83	7.75		9.07	8.39		
1989	4.73	8.38	7.99	6.77	6.26	8.55	7.31		8.04
1990									
MEAN	4.90	8.64	8.25	8.96	6.26	8.95	8.52	6.53	8.04
VARIANCE	0.61	0.93	1.26	2.01	0.00	1.62	2.98	0.98	0.00
STD DEV	0.78	0.96	1.12	1.42	0.00	1.27	1.73	0.99	0.00

COMPARI[redacted] OF TOTAL MONTHLY PAN EVAPORATION (April-October, 19[redacted]990)

OCTOBER

	FT. COLLINS (Larimer Co.) (EL=5004' MSL) (Platte D.B.) (in./30 days)	PUEBLO WSO AP (Pueblo) (EL=4684) (Ark. D.B.) (in./30 days)	PUEBLO RES. (Pueblo) (EL=4555) (Ark. D.B.) (in./30 days)	SPRINGFIELD 7 WSW (Baca) (EL=4580) (Ark. D.B.) (in./30 days)	TRINIDAD LAKE (Las Animas) (EL=6120) (Ark. D.B.) (in./30 days)	AKRON 4 E (Washington) (EL=4540) (Kansas D.B) (in./30 days)	BONNY LAKE (Yuma) (EL=3748) (Kansas D.B.) (in./30 days)	CHERRY CREEK DAM Reservoir E (Arapahoe) (EL=5646) Converted to (in./30 days)	ROCKY FLATS (Jefferson) (EL=~6100) Calculated (in./30 days)
1948								5.31	
1949								4.39	
1950								5.89	
1951								8.63	
1952								5.73	
1953	3.92						8.18	5.34	
1954	3.58						6.2	4.99	
1955	3.55						7.04	5.46	
1956	4.09			10.34			8.57	5.83	
1957	2.26			5.57			4.35	3.71	
1958	3.73			7.76			7.31	5.39	
1959	2.25			6.06			5.34	4.29	
1960	3.23			6.58			6.36	4.59	
1961	3.09			7.45			5.71	4.71	
1962	3.16			8.24			6.16	5.09	
1963	2.99			9.07			7.11	4.97	
1964	3.25			8.09			7.06	5.70	
1965	3.25			6.33			5.74	5.01	
1966	3.5			6.26			6.48	5.04	
1967	2.83			7.46			7.43	4.74	
1968	3.05			7.59				4.97	
1969				3.65				3.60	
1970	2.67			3.97				3.01	
1971	2.96	7.49		6.72			6.5	4.50	
1972	3.05	5.27		4.99		5.14	4.83	4.27	
1973	3.33	6.68		6.45		5.72	4.8	4.10	
1974	3.79	5.80		6.37		6.29	5.39	3.97	
1975		7.94	7.4	8.99		7.35	7.43	6.43	
1976			5.43	4.84				3.54	
1977		7.57	6.51	6.7		7.33	5.69	6.13	
1978	3.82	6.57	6.62	7.17		7.61		5.69	
1979	3.91		6.24	7.29		7.6		4.46	
1980			6.77	7.28		7.58		5.80	
1981			6.13	5.49		5.63		4.00	
1982			4.73	6.45		5.25		3.67	
1983	3.26	6.27	5.78	6.01		6.71		8.07	
1984				3.49		4.08			
1985	3.18	5.84		5.43					
1986	2.65	5.26	4.21	4.41		4.61			
1987		6.36		5.71					
1988	3.62	6.04	5.26	5.48		6.77	5.84		
1989	3.62		5.95	5.97	5.62	7.68			5.49
1990									
MEAN	3.27	6.42	5.92	6.46	5.62	6.36	6.34	5.03	5.49
VARIANCE	0.23	0.77	0.81	2.36	0.00	1.46	1.21	1.33	0.00
STD DEV	0.47	0.88	0.90	1.54	0.00	1.21	1.10	1.15	0.00

B

APPENDIX B

MEYER C CALCULATIONS

MEYER C CALCULATIONS

FROM FORT COLLINS DATA (AND DENVER RELATIVE HUMIDITY DATA) 1953-1989

MEYER EQUATION

E = C(Ew-Ea)(1 + 0.1W)

C = E/[(Ew-Ea)(1 + 0.1W)]

E = TOTAL PAN EVAPORATION (INCHES/30 DAYS); from Fort Collins NOAA data

W = WIND VELOCITY (MPH); from Fort Collins NOAA data

T = AIR TEMPERATURE (degrees F); from Fort Collins NOAA data

RH = RELATIVE HUMIDITY (%); From Denver "local" NOAA data

Ew = SATURATION VAPOR PRESSURE CORRESPONDING TO AIR OR WATER TEMP (INCHES Hg)
=(0.0041T + 0.676)^8 - 0.000019|T + 16| + 0.001316
(^ = exponent)

Ea = ACTUAL VAPOR PRESSURE BASED ON AIR TEMP AND RELATIVE HUMIDITY (INCHES Hg)
=(RH)(Ew)/100

MEAN = [SUM (Xi)]/N

VARIANCE = {SUM [(Xi-MEAN)^2]}/(N-1)

STANDARD DEVIATION = VARIANCE ^0.5

APRIL

	PAN E (in./30 days)	(E-Eav)^2	W (Mi./month)	W (Mi./hour)	(W-Wav)^2	T (F)	(T-Tav)^2	RH (%)	(RH-RHav)^2	Ew	(Ew-Ewav)^2	Ea	(Ea-Eaav)^2	C	(C-Cav)^2
1953	3.17	3.16	1747	2.4	0.00	41.6	29.22	56.8	64.00	0.265	0.00	0.150	0.00	22.290	4.24
1954	6.48	2.35	2177	3.0	0.30	52.3	28.03	34.0	217.56	0.396	0.00	0.135	0.00	19.046	28.13
1955	6.92	3.90	2730	3.8	1.72	48.4	1.94	28.3	420.25	0.343	0.00	0.097	0.00	20.414	15.49
1956	4.22	0.53	2021	2.8	0.11	44.8	4.86	48.3	0.25	0.299	0.00	0.144	0.00	21.288	9.37
1957	2.71	5.00	1631	2.3	0.05	40	49.08	63.8	225.00	0.249	0.01	0.159	0.00	24.504	0.02
1958	4.28	0.44	2201	3.1	0.33	43.8	10.27	52.3	12.25	0.288	0.00	0.150	0.00	23.843	0.26
1959	4.72	0.05	1875	2.6	0.02	43.1	15.25	47.5	1.56	0.280	0.00	0.133	0.00	25.446	1.20
1960	5.39	0.20	2351	3.3	0.62	49.3	5.27	39.3	90.25	0.354	0.00	0.139	0.00	18.881	29.91
1961	4.26	0.47				45.7	1.70	49.8	1.00	0.309	0.00	0.154	0.00	27.393	9.26
1962						48.9	3.59	45.3	12.25	0.349	0.00	0.158	0.00		
1963			2145	3.0	0.25	48.3	1.68	35.3	182.25	0.341	0.00	0.120	0.00		
1964			2229	3.1	0.38	45.5	2.27	49.3	0.25	0.307	0.00	0.151	0.00		
1965			1802	2.5	0.00	49	3.98	46.8	4.00	0.350	0.00	0.164	0.00		
1966						44.9	4.43	54.8	36.00	0.300	0.00	0.164	0.00		
1967	5.53	0.34				49.1	4.39	48.8	0.00	0.352	0.00	0.171	0.00	30.687	40.16
1968						42.7	18.54	54.0	27.56	0.276	0.00	0.149	0.00		
1969						51.7	22.04	51.0	5.06	0.387	0.00	0.197	0.00		
1970						42.5	20.30	50.5	3.06	0.274	0.00	0.138	0.00		
1971						46.9	0.01	54.8	36.00	0.324	0.00	0.177	0.00		
1972						48.5	2.23	57.5	76.56	0.344	0.00	0.198	0.00		
1973						42.4	21.21	51.3	6.25	0.273	0.00	0.140	0.00		
1974						47.2	0.04	49.3	0.25	0.327	0.00	0.161	0.00		
1975						43.3	13.73	51.0	5.06	0.282	0.00	0.144	0.00		
1976						48.6	2.54	50.3	2.25	0.345	0.00	0.173	0.00		
1977						50.0	8.97	54.8	36.00	0.364	0.00	0.199	0.00		
1978	5.51	0.31	1690	2.3	0.02	49.6	6.73	47.0	3.06	0.358	0.00	0.168	0.00		
1979						48.5	2.23	45.5	10.56	0.344	0.00	0.156	0.00		
1980						46.2	0.65	46.3	6.25	0.315	0.00	0.146	0.00		
1981						54.2	51.76	41.8	49.00	0.424	0.01	0.177	0.00		
1982			2031	2.8	0.12	47.2	0.04	37.5	126.56	0.327	0.00	0.123	0.00		
1983			1269	1.8	0.51	41.0	36.06	59.5	115.56	0.259	0.00	0.154	0.00		
1984	4.81	0.02	1614	2.2	0.06	42.7	18.54	56.8	64.00	0.276	0.00	0.157	0.00	32.910	73.27
1985	5.38	0.19	1088	1.5	0.94	51.9	23.96	48.5	0.06	0.390	0.00	0.189	0.00	23.268	1.17
1986	4.26	0.47	1092	1.5	0.93	49.1	4.39			0.352	0.00				
1987	5.54	0.35	1316	1.8	0.42	51.0	15.96			0.377	0.00				
1988	5.14	0.04	1163	1.6	0.75	48.8	3.22	49.3	0.25	0.348	0.00	0.171	0.00	25.077	0.53
1989	5.77	0.68	1522	2.1	0.13	50.5	12.21	50.3	2.25	0.370	0.00	0.186	0.00	25.849	2.25
MEAN	4.95			2.48		47.01		48.8		0.33		0.16		24.35	
VARIANCE	1.16			0.40		12.54		54.19		0.00		0.00		16.56	
STD DEV	1.08			0.63		3.54		7.36		0.04		0.02		4.07	

MAY

	PAN E (in./31 days)	PAN E (in./30 days)	(E-Eav)^2	W (Mi./month)	W (Mi./hour)	(W-Wav)^2	T (F)	(T-Tav)^2	RH (%)	(RH-RHav)^2	Ew	(Ew-Ewav)^2	Ea	(Ea-Eaav)^2	C	(C-Cav)^2
1953	5.53	5.35	0.02	2025	2.7	0.96	52.7	13.41	49.8	2.61	0.402	0.74	0.200	0.00	20.842	1.28
1954	5.69	5.51	0.00	1735	2.3	0.35	56	0.13	49.0	5.59	0.453	0.83	0.222	0.00	19.331	0.15
1955	7.69	7.44	3.86	2185	2.9	1.43	57.8	2.07	40.8	112.66	0.483	0.89	0.197	0.00	20.091	0.14
1956	5.19	5.02	0.21	1368	1.8	0.01	58.3	3.76	46.8	21.29	0.492	0.91	0.230	0.00	16.195	12.37
1957	4.92	4.76	0.51	1440	1.9	0.04	52.4	15.70	58.5	50.92	0.397	0.74	0.232	0.00	24.197	20.12
1958	5.08	4.92	0.32	1159	1.6	0.03	60.2	14.73	50.8	0.38	0.526	0.97	0.267	0.00	16.406	10.92
1959	4.91	4.75	0.53	1342	1.8	0.00	54.7	2.76	54.5	9.83	0.432	0.80	0.235	0.00	20.476	0.58
1960	5.17	5.00	0.22	1125	1.5	0.05	55.4	0.93	46.5	23.66	0.443	0.82	0.206	0.00	18.329	1.91
1961	4.56	4.41	1.13	1188	1.6	0.02	56	0.13	63.5	147.28	0.453	0.83	0.288	0.00	23.018	10.93
1962	5.37	5.20	0.08				57.7	1.79	43.3	65.84	0.482	0.89	0.208	0.00		
1963	5.17	5.00	0.22	970	1.3	0.19	58.6	5.01	41.0	107.42	0.497	0.92	0.204	0.00	15.086	21.39
1964	5.86	5.67	0.04	1472	2.0	0.06	57.9	2.36	44.8	43.75	0.485	0.89	0.217	0.00	17.669	4.17
1965	4.16	4.03	2.11	1443	1.9	0.04	55.5	0.74	51.0	0.13	0.445	0.82	0.227	0.00	15.470	17.99
1966	6.12	5.92	0.20				58.9	6.44	41.0	107.42	0.503	0.93	0.206	0.00		
1967	3.97	3.84	2.67				52.9	11.99	64.0	159.66	0.405	0.75	0.259	0.00		
1968							53	11.30	54.8	11.46	0.406	0.75	0.222	0.00		
1969							57.9	2.36	57.8	40.78	0.485	0.89	0.280	0.00		
1970				1156	1.6	0.03	58.7	5.47	47.8	13.06	0.499	0.92	0.238	0.00		
1971				1181	1.6	0.02	54.4	3.85	62.0	113.12	0.427	0.79	0.265	0.00		
1972	5.13	4.96	0.26	1320	1.8	0.00	56.5	0.02	56.3	23.87	0.461	0.85	0.259	0.00	20.898	1.41
1973							55.8	0.32	50.8	0.38	0.450	0.83	0.228	0.00		
1974	7.92	7.66	4.78	1467	2.0	0.05	60.4	16.30	40.8	112.66	0.530	0.98	0.216	0.00	20.381	0.45
1975							53.3	9.38	53.0	2.68	0.411	0.76	0.218	0.00		
1976				983	1.3	0.18	56.2	0.03	51.8	0.15	0.456	0.84	0.236	0.00		
1977				1427	1.9	0.03	59.7	11.14	45.3	37.38	0.517	0.96	0.234	0.00		
1978	6.75	6.53	1.11	1170	1.6	0.03	54.0	5.58	53.3	3.56	0.421	0.78	0.224	0.00		
1979	5.28	5.11	0.14	945	1.3	0.22	53.8	6.56	57.5	37.65	0.418	0.77	0.240	0.00		
1980							54.4	3.85	54.0	6.95	0.427	0.79	0.231	0.00		
1981							54.7	2.76	57.5	37.65	0.432	0.80	0.248	0.00		
1982				1370	1.8	0.01	55.2	1.35	54.3	8.33	0.440	0.81	0.239	0.00		
1983				1173	1.6	0.03	52.5	14.92	59.5	66.19	0.399	0.74	0.237	0.00		
1984	6.84	6.62	1.30	1386	1.9	0.01	59.0	6.96	46.5	23.66	0.504	0.93	0.235	0.00	20.677	0.93
1985	6.64	6.43	0.90	971	1.3	0.19	59.6	10.48	47.5	14.93	0.515	0.95	0.245	0.00	21.010	1.69
1986	5.57	5.39	0.01	648	0.9	0.76	56.3	0.00			0.458	0.84		0.05		
1987	5.34	5.17	0.10	880	1.2	0.31	58.3	3.76			0.492	0.91		0.05		
1988							58.4	4.15	48.8	6.83	0.494	0.91	0.241	0.00		
1989	6.98	6.75	1.63	1435	1.9	0.04	58.3	3.76	54.0	6.95	0.492	0.91	0.266	0.00	25.022	28.20
MEAN		5.48			1.74		56.36		51.4		0.46		0.23		19.71	
VARIANCE		0.97			0.20		5.73		41.96		0.87		0.00		8.41	
STD DEV		0.99			0.44		2.39		6.48		0.93		0.06		2.90	

MEYER C CALCULATIONS

JUNE

	PAN E (in./30 days)	(E-Eav)^2	W (Mi./month)	W (Mi./hour)	(W-Wav)^2	T (F)	(T-Tav)^2	RH (%)	(RH-RHav)^2	Ew	(Ew-Ewav)^2	Ea	(Ea-Eaav)^2	C	(C-Cav)^2
1953	6.73	0.06	1019	1.4	0.00	67.6	3.25	43.3	27.56	0.682	0.00	0.295	0.00	15.241	4.27
1954	8.35	3.51	1634	2.3	0.67	67.2	1.97	35.0	182.25	0.672	0.00	0.235	0.01	15.573	3.00
1955	5.28	1.43	1131	1.6	0.01	62.1	13.67	49.3	0.56	0.563	0.01	0.277	0.00	15.972	1.78
1956	7.95	2.17	1141	1.6	0.02	69.8	16.02	33.3	232.56	0.735	0.01	0.244	0.00	13.990	11.00
1957	6.33	0.02	912	1.3	0.03	64.8	0.99	46.0	6.25	0.619	0.00	0.285	0.00	16.816	0.24
1958	6.52	0.00	1171	1.6	0.03	66.9	1.22	51.5	9.00	0.665	0.00	0.343	0.00	17.377	0.00
1959	6.14	0.11	825	1.1	0.09	67.9	4.42	41.8	45.56	0.689	0.00	0.288	0.00	13.732	12.78
1960	7.15	0.45	1140	1.6	0.02	67	1.45	45.0	12.25	0.668	0.00	0.300	0.00	16.809	0.25
1961	4.78	2.88	420	0.6	0.75	65.2	0.36	51.8	10.56	0.627	0.00	0.325	0.00	14.920	5.70
1962	4.94	2.36				63.1	7.28	50.0	2.25	0.583	0.00	0.292	0.00		
1963	6.16	0.10				66.8	1.01	47.8	0.56	0.663	0.00	0.317	0.00		
1964	5.14	1.79	1010	1.4	0.00	63.6	4.83	54.3	33.06	0.593	0.00	0.322	0.00	16.605	0.49
1965	4.39	4.36	883	1.2	0.05	63.3	6.24	61.5	169.00	0.587	0.00	0.361	0.00	17.298	0.00
1966	6.04	0.19	1246	1.7	0.08	64.8	0.99	52.8	18.06	0.619	0.00	0.326	0.00	17.612	0.09
1967	2.818	13.39				60.5	28.06	74.3	663.06	0.532	0.01	0.395	0.01		
1968	6.52	0.00	1294	1.8	0.12	67.2	1.97	44.3	18.06	0.672	0.00	0.297	0.00	14.745	6.56
1969	4.68	3.23	1108	1.5	0.01	60.2	31.33	58.8	105.06	0.526	0.01	0.309	0.00	18.678	1.88
1970	5.69	0.62				64.7	1.20	52.3	14.06	0.617	0.00	0.322	0.00		
1971	5.74	0.54	1007	1.4	0.00	67.8	4.01	44.0	20.25	0.686	0.00	0.302	0.00	13.102	17.68
1972	6.25	0.05	1119	1.6	0.01	67.6	3.25	58.3	95.06	0.682	0.00	0.397	0.01	19.008	2.90
1973			1338	1.9	0.17	66.8	1.01	39.5	81.00	0.663	0.00	0.262	0.00		
1974	7.16	0.47	1097	1.5	0.01	66.5	0.49	44.3	18.06	0.656	0.00	0.290	0.00	16.982	0.11
1975	6.96	0.23	1137	1.6	0.02	63.5	5.28	50.5	4.00	0.591	0.00	0.299	0.00	20.536	10.43
1976	7.56	1.17	1034	1.4	0.00	64.9	0.81	38.3	105.06	0.621	0.00	0.237	0.00	17.242	0.00
1977	8.53	4.21	1179	1.6	0.04	71.3	30.28	45.0	12.25	0.773	0.02	0.348	0.00	17.234	0.01
1978	7.58	1.22	929	1.3	0.03	66.4	0.36	48.0	0.25	0.654	0.00	0.314	0.00	19.741	5.93
1979	5.50	0.96	856	1.2	0.07	64.9	0.81	48.5	0.00	0.621	0.00	0.301	0.00	15.373	3.74
1980						69.2	11.58	32.3	264.06	0.720	0.01	0.232	0.01		
1981	8.35	3.51	1194	1.7	0.04	68.7	8.43	45.8	7.56	0.708	0.00	0.324	0.00	18.652	1.81
1982	7.78	1.70	1232	1.7	0.07	61.8	15.98	55.0	42.25	0.557	0.01	0.306	0.00	26.502	84.55
1983	6.63	0.02				62.5	10.87	57.5	81.00	0.571	0.01	0.328	0.00		
1984	6.08	0.16	915	1.3	0.03	64.2	2.55	51.3	7.56	0.606	0.00	0.311	0.00	18.262	0.91
1985	7.49	1.02	975	1.4	0.01	66.1	0.09	41.5	49.00	0.647	0.00	0.269	0.00	17.422	0.01
1986	7.45	0.95	237	0.3	1.26	68.3	6.26			0.698	0.00				
1987	7.63	1.33	957	1.3	0.01	67.1	1.70			0.670	0.00				
1988	8.24	3.11	1081	1.5	0.00	70.2	19.38	49.8	1.56	0.745	0.01	0.371	0.00	19.138	3.35
1989	6.18	0.09	1145	1.6	0.02	64.0	3.23	55.8	52.56	0.602	0.00	0.335	0.00	20.026	7.39
MEAN	6.48			1.45		65.80		48.5		0.64		0.31		17.31	
VARIANCE	1.69			0.12		7.02		70.33		0.00		0.00		6.92	
STD DEV	1.30			0.35		2.65		8.39		0.06		0.04		2.63	

JULY

	PAN E (in./31 days)	PAN E (in./30 days)	(E-Eav)^2	W (Mi./month)	W (Mi./hour)	(W-Wav)^2	T (F)	(T-Tav)^2	RH (%)	(RH-RHav)^2	Ew	(Ew-Ewav)^2	Ea	(Ea-Eaav)^2	C	(C-Cav)^2
1953	6.96	6.74	0.07	893	1.2	0.00	71.4	0.01	49.0	2.79	0.776	0.00	0.380	0.00	15.197	0.00
1954	8.95	8.66	2.73	1302	1.8	0.24	74.7	10.12	43.3	16.63	0.867	0.01	0.375	0.00	14.984	0.05
1955	8.71	8.43	2.02	994	1.3	0.01	73	2.19	37.5	96.60	0.819	0.00	0.307	0.00	14.528	0.46
1956	7.66	7.41	0.16	1053	1.4	0.02	70.1	2.01	43.8	12.81	0.742	0.00	0.325	0.00	15.550	0.12
1957	7.13	6.90	0.01	819	1.1	0.03	71.7	0.03	49.0	2.79	0.784	0.00	0.384	0.00	15.549	0.12
1958	6.14	5.94	1.14	910	1.2	0.00	68	12.38	53.8	41.23	0.691	0.01	0.371	0.00	16.565	1.85
1959	7.26	7.03	0.00	868	1.2	0.01	71	0.27	36.5	117.26	0.765	0.00	0.279	0.01	12.944	5.11
1960	7.65	7.40	0.16	1001	1.3	0.01	70.9	0.38	42.5	23.32	0.763	0.00	0.324	0.00	14.876	0.11
1961	5.46	5.28	2.97				69.7	3.31	50.8	11.71	0.732	0.00	0.372	0.00		
1962	5.61	5.43	2.49				68.6	8.52	46.8	0.33	0.705	0.01	0.330	0.00		
1963	6.99	6.76	0.06	1249	1.7	0.18	73.4	3.54	44.3	9.48	0.830	0.00	0.367	0.00	12.518	7.22
1964	6.34	6.14	0.76	980	1.3	0.00	73.8	5.20	39.3	65.26	0.841	0.00	0.330	0.00	10.609	21.12
1965	5.56	5.38	2.65	715	1.0	0.09	70.7	0.67	56.8	88.76	0.758	0.00	0.430	0.00	14.979	0.05
1966	7.12	6.89	0.01	1017	1.4	0.01	74.8	10.77	49.0	2.79	0.870	0.01	0.426	0.00	13.666	2.37
1967	4.23	4.09	8.49	235	0.3	0.89	70.1	2.01	66.5	367.54	0.742	0.00	0.494	0.02	15.955	0.56
1968	6.3	6.10	0.83	1042	1.4	0.02	70.6	0.84	49.0	2.79	0.755	0.00	0.370	0.00	13.886	1.74
1969	6.60	6.39	0.39				72.5	0.96	50.5	10.06	0.805	0.00	0.407	0.00		
1970	6.76	6.54	0.22	837	1.1	0.02	71.2	0.10	54.8	55.08	0.771	0.00	0.422	0.00	16.862	2.75
1971	6.35	6.15	0.74	1152	1.5	0.08	69.1	5.85	53.8	41.23	0.718	0.00	0.386	0.00	16.034	0.69
1972	6.20	6.00	1.02	1098	1.5	0.05	68.5	9.11	55.3	62.75	0.703	0.01	0.388	0.00	16.620	2.00
1973	6.51	6.30	0.50	1012	1.4	0.01	68.9	6.86	49.3	3.69	0.713	0.00	0.351	0.00	15.333	0.02
1974	7.84	7.59	0.34	1046	1.4	0.02	72.4	0.78	45.0	5.42	0.803	0.00	0.361	0.00	15.070	0.02
1975	7.72	7.47	0.21	978	1.3	0.00	71.7	0.03	45.3	4.32	0.784	0.00	0.355	0.00	15.387	0.03
1976	7.95	7.69	0.47	1039	1.4	0.02	72.5	0.96	42.3	25.79	0.805	0.00	0.340	0.00	14.517	0.47
1977	9.34	9.04	4.12	1148	1.5	0.08	72.9	1.91	49.5	4.72	0.816	0.00	0.404	0.00	18.999	14.40
1978	7.63	7.38	0.14	908	1.2	0.00	72.4	0.78	40.3	50.11	0.803	0.00	0.323	0.00	13.724	2.19
1979	6.45	6.24	0.59	731	1.0	0.08	71.9	0.15	42.5	23.32	0.789	0.00	0.335	0.00	12.526	7.17
1980							73.6	4.33	42.5	23.32	0.836	0.00	0.355	0.00		
1981	8.9	8.61	2.58	928	1.2	0.00	72.1	0.34	44.5	8.00	0.794	0.00	0.354	0.00	17.367	4.68
1982	9.1	8.81	3.23	911	1.2	0.00	71.0	0.27	44.5	8.00	0.765	0.00	0.341	0.00	18.468	10.65
1983	7.82	7.57	0.31	1042	1.4	0.02	71.9	0.15	50.0	7.14	0.789	0.00	0.395	0.00	16.824	2.62
1984	7.97	7.71	0.50	999	1.3	0.01	72.5	0.96	48.5	1.37	0.805	0.00	0.391	0.00	16.397	1.42
1985	6.37	6.16	0.71	751	1.0	0.06	71.3	0.05	46.8	0.33	0.773	0.00	0.362	0.00	13.598	2.58
1986	7.64	7.39	0.15	281	0.4	0.78	71.1	0.18			0.768	0.00				
1987	9.72	9.41	5.75	1024	1.4	0.01	71.7	0.03			0.784	0.00				
1988	7.32	7.08	0.01	923	1.2	0.00	71.7	0.03	48.0	0.45	0.784	0.00	0.376	0.00	15.462	0.07
1989	8.44	8.17	1.34	1028	1.4	0.02	72.8	1.64	46.0	1.77	0.813	0.00	0.374	0.00	16.338	1.28
MEAN		7.01			1.26		71.52		47.3		0.78		0.37		15.20	
VARIANCE		1.37			0.09		2.71		35.26		0.00		0.00		3.13	
STD DEV		1.17			0.29		1.65		5.94		0.04		0.04		1.77	

AUGUST

	PAN E (in./31 days)	PAN E (in./30 days)	(E-Eav)^2	W (Mi./month)	W (Mi./hour)	(W-Wav)^2	T (F)	(T-Tav)^2	RH (%)	(RH-RHav)^2	Ew	(Ew-Ewav)^2	Ea	(Ea-Eaav)^2	C	(C-Cav)^2
1953	6.68	6.46	0.13	800	1.1	0.01	68.3	0.99	47.8	0.62	0.698	0.00	0.333	0.00	16.000	1.09
1954	7.2	6.97	0.76	994	1.3	0.03	69.6	0.09	42.0	42.72	0.730	0.00	0.307	0.00	14.519	0.19
1955	6.16	5.96	0.02	668	0.9	0.07	71.2	3.63	52.8	17.76	0.771	0.00	0.407	0.00	15.022	0.00
1956	6.06	5.86	0.05	877	1.2	0.00	66.8	6.22	45.3	10.80	0.663	0.00	0.300	0.00	14.450	0.26
1957	6.14	5.94	0.02	798	1.1	0.01	69.8	0.26	51.8	10.33	0.735	0.00	0.380	0.00	15.134	0.03
1958	7.11	6.88	0.61	748	1.0	0.02	71.6	5.31	42.8	33.47	0.781	0.00	0.334	0.00	13.980	0.95
1959	6.43	6.22	0.02	754	1.0	0.02	71.3	4.02	42.0	42.72	0.773	0.00	0.325	0.00	12.597	5.56
1960	8.15	7.89	3.20	1152	1.5	0.15	69.8	0.26	36.3	150.94	0.735	0.00	0.266	0.01	14.578	0.14
1961	5.07	4.91	1.42				70	0.50	54.8	38.62	0.740	0.00	0.405	0.00		
1962	5.33	5.16	0.88				68.1	1.43	36.3	150.94	0.693	0.00	0.251	0.01		
1963	4.41	4.27	3.35	893	1.2	0.00	69	0.09	65.8	296.33	0.715	0.00	0.470	0.01	15.557	0.36
1964	5.99	5.80	0.09	1059	1.4	0.07	67	5.27	36.0	157.14	0.668	0.00	0.240	0.01	11.875	9.49
1965	5.48	5.30	0.63	772	1.0	0.02	67.3	3.98	52.8	17.76	0.675	0.00	0.356	0.00	15.073	0.01
1966	6.44	6.23	0.02	968	1.3	0.02	67.8	2.23	53.3	22.22	0.686	0.00	0.365	0.00	17.188	4.98
1967	5.14	4.97	1.26	436	0.6	0.33	67.8	2.23	51.8	10.33	0.686	0.00	0.355	0.00	14.190	0.59
1968	5.76	5.57	0.27	975	1.3	0.02	66.9	5.73	54.5	35.57	0.665	0.00	0.363	0.00	16.278	1.75
1969	6.60	6.39	0.08	871	1.2	0.00	71.6	5.31	49.5	0.93	0.781	0.00	0.387	0.00	14.494	0.21
1970	5.78	5.59	0.25	799	1.1	0.01	71.6	5.31	51.5	8.79	0.781	0.00	0.402	0.00	13.332	2.64
1971	6.54	6.33	0.05	1023	1.4	0.04	70.4	1.22	50.8	4.90	0.750	0.00	0.381	0.00	15.062	0.01
1972	5.67	5.49	0.37	941	1.3	0.01	68.5	0.63	58.0	89.57	0.703	0.00	0.408	0.00	16.498	2.38
1973	6.83	6.61	0.26	1059	1.4	0.07	71.2	3.63	41.3	53.08	0.771	0.00	0.318	0.00	12.779	4.74
1974	6.74	6.52	0.18	1141	1.5	0.14	66.5	7.81	46.8	3.19	0.656	0.00	0.307	0.00	16.183	1.51
1975	7.40	7.16	1.13	976	1.3	0.02	69.2	0.01	41.0	56.79	0.720	0.00	0.295	0.00	14.903	0.00
1976	6.08	5.88	0.05	902	1.2	0.00	68.4	0.80	46.3	5.22	0.701	0.00	0.324	0.00	13.936	1.04
1977	6.06	5.86	0.05	837	1.1	0.00	68.2	1.20	52.8	17.76	0.696	0.00	0.367	0.00	16.034	1.16
1978	7.04	6.81	0.51	887	1.2	0.00	68.1	1.43	44.0	20.57	0.693	0.00	0.305	0.00	15.671	0.51
1979	5.26	5.09	1.01	571	0.8	0.16	67.1	4.82	50.0	2.14	0.670	0.00	0.335	0.00	14.112	0.71
1980							69.3	0.00	43.0	30.64	0.722	0.00	0.311	0.00		
1981	6.24	6.04	0.00	758	1.0	0.02	68.6	0.48	51.5	8.79	0.705	0.00	0.363	0.00	16.019	1.13
1982	7.55	7.31	1.46	1066	1.4	0.07	71.8	6.28	52.3	13.80	0.786	0.00	0.411	0.00	17.018	4.25
1983	6.80	6.58	0.23	972	1.3	0.02	73.8	20.30	52.3	13.80	0.841	0.01	0.440	0.01	14.491	0.22
1984	6.41	6.20	0.01	862	1.2	0.00	70.9	2.58	56.5	63.43	0.763	0.00	0.431	0.01	16.752	3.23
1985	6.83	6.61	0.26	886	1.2	0.00	69.6	0.09	42.5	36.43	0.730	0.00	0.310	0.00	14.073	0.78
1986	6.39	6.18	0.01	149	0.2	0.93	69.3	0.00			0.722	0.00				
1987	6.50	6.29	0.04	1057	1.4	0.07	68.2	1.20			0.696	0.00				
1988	6.33	6.13	0.00	818	1.1	0.00	70.9	2.58	51.5	8.79	0.763	0.00	0.393	0.00	14.916	0.00
1989	6.22	6.02	0.01	953	1.3	0.01	68.4	0.80	52.0	12.00	0.701	0.00	0.364	0.00	15.867	0.83
MEAN		6.10			1.16		69.29		48.5		0.72		0.35		14.96	
VARIANCE		0.54			0.07		3.02		43.79		0.00		0.00		1.64	
STD DEV		0.73			0.27		1.74		6.62		0.04		0.05		1.28	

SEPTEMBER

	PAN E (in./30 days)	(E-Eav)^2	W (Mi./month)	W (Mi./hour)	(W-Wav)^2	T (F)	(T-Tav)^2	RH (%)	(RH-RHav)^2	Ew	(Ew-Ewav)^2	Ea	(Ea-Eaav)^2	C	(C-Cav)^2
1953	6.61	2.91	1093	1.5	0.06	62.2	3.47	31.8	251.68	0.565	0.00	0.179	0.01	14.884	1.28
1954	5.63	0.53	992	1.4	0.01	62.7	5.58	43.0	21.29	0.575	0.00	0.247	0.00	15.099	0.84
1955	5.44	0.29	960	1.3	0.00	61	0.44	44.8	8.20	0.542	0.00	0.242	0.00	16.043	0.00
1956	6.21	1.70	913	1.3	0.00	62.7	5.58	33.0	213.58	0.575	0.00	0.190	0.00	14.306	2.92
1957	5.06	0.02	782	1.1	0.04	58.4	3.76	44.3	11.32	0.494	0.00	0.218	0.00	16.582	0.32
1958	5.45	0.30	785	1.1	0.03	62.4	4.25	44.3	11.32	0.569	0.00	0.252	0.00	15.493	0.27
1959	4.97	0.00	879	1.2	0.00	58	5.47	41.0	43.75	0.487	0.00	0.200	0.00	15.424	0.35
1960	5.93	1.05	943	1.3	0.00	62.5	4.67	42.5	26.16	0.571	0.00	0.243	0.00	15.972	0.00
1961	3.19	2.94				54.7	31.79	59.0	129.63	0.432	0.01	0.255	0.00		
1962	4.45	0.21				59.8	0.29	48.0	0.15	0.519	0.00	0.249	0.00		
1963	4.5	0.16	696	1.0	0.10	64	13.41	54.8	50.92	0.602	0.01	0.329	0.01	15.070	0.89
1964	4.46	0.20	1021	1.4	0.02	59.7	0.41	43.0	21.29	0.517	0.00	0.222	0.00	13.251	7.65
1965	3.75	1.33	960	1.3	0.00	52.9	55.32	61.3	185.93	0.405	0.02	0.248	0.00	21.104	25.88
1966	4.7	0.04	843	1.2	0.01	61.7	1.86	52.0	19.23	0.555	0.00	0.289	0.00	15.791	0.05
1967	3.54	1.86	407	0.6	0.50	60.2	0.02	49.3	2.68	0.526	0.00	0.259	0.00	12.542	12.07
1968	4.57	0.11	746	1.0	0.06	58.9	2.07	50.8	9.83	0.503	0.00	0.255	0.00	16.728	0.51
1969	5.00	0.01	3133	4.4	9.46	62.2	3.47	54.8	50.92	0.565	0.00	0.309	0.00	13.629	5.70
1970	4.70	0.04	987	1.4	0.01	58.3	4.15	54.5	47.41	0.492	0.00	0.268	0.00	18.465	6.00
1971	4.76	0.02	997	1.4	0.01	56.0	18.82	56.0	70.32	0.453	0.01	0.254	0.00	20.980	24.64
1972	4.66	0.06	1132	1.6	0.09	60.1	0.06	58.0	107.86	0.525	0.00	0.304	0.00	18.278	5.12
1973	4.47	0.19	1108	1.5	0.07	58.6	3.02	53.0	29.01	0.497	0.00	0.264	0.00	16.575	0.31
1974	4.67	0.06	859	1.2	0.01	58.1	5.01	48.0	0.15	0.488	0.00	0.234	0.00	16.426	0.17
1975						59.3	1.08	44.0	13.06	0.510	0.00	0.224	0.00		
1976	4.22	0.47	729	1.0	0.07	60.5	0.03	54.3	44.03	0.532	0.00	0.289	0.00	15.743	0.07
1977	6.24	1.78	898	1.2	0.00	64.6	18.17	34.3	178.60	0.614	0.01	0.210	0.00	13.733	5.21
1978	6.07	1.36	827	1.1	0.02	63.2	8.19	34.0	185.35	0.585	0.00	0.199	0.00	14.099	3.68
1979	5.27	0.13	534	0.7	0.28	63.8	11.99	40.8	47.12	0.598	0.00	0.243	0.00	13.858	4.66
1980						62.6	5.12	40.5	50.61	0.573	0.00	0.232	0.00		
1981	5.49	0.34	709	1.0	0.08	64.6	18.17	44.3	11.32	0.614	0.01	0.272	0.00	14.590	2.03
1982	3.98	0.86	886	1.2	0.00	59.5	0.70	57.8	102.73	0.513	0.00	0.297	0.00	16.335	0.10
1983	5.41	0.26	1052	1.5	0.03	62.6	5.12	43.8	14.93	0.573	0.00	0.251	0.00	14.647	1.88
1984	4.67	0.06	972	1.4	0.01	59.7	0.41	51.8	17.10	0.517	0.00	0.268	0.00	16.489	0.22
1985	4.70	0.04	912	1.3	0.00	57.6	7.50	52.8	26.38	0.480	0.00	0.253	0.00	18.402	5.69
1986	4.03	0.77	218	0.3	0.95	58.8	2.36			0.501	0.00				
1987	4.53	0.14	695	1.0	0.10	60.3	0.00			0.528	0.00				
1988	5.61	0.50	821	1.1	0.02	60.1	0.06	46.8	0.75	0.525	0.00	0.245	0.00	18.028	4.05
1989	4.73	0.03	815	1.1	0.02	60.2	0.02	55.0	54.55	0.526	0.00	0.290	0.00	17.937	3.69
MEAN	4.90			1.28		60.34		47.6		0.53		0.25		16.02	
VARIANCE	0.61			0.38		6.99		60.56		0.00		0.00		4.21	
STD DEV	0.78			0.61		2.64		7.78		0.05		0.03		2.05	

OCTOBER

	PAN E (in./31 days)	PAN E (in./30 days)	(E-Eav)^2	W (Mi./month)	W (Mi./hour)	(W-Wav)^2	T (F)	(T-Tav)^2	RH (%)	(RH-RHav)^2	Ew	(Ew-Ewav)^2	Ea	(Ea-Eaav)^2	C	(C-Cav)^2
1953	3.92	3.79	0.39	823	1.1	0.00	51.3	1.94	38.8	80.49	0.382	0.00	0.148	0.00	14.618	0.00
1954	3.58	3.46	0.09	1166	1.6	0.19	50.1	0.04	44.0	13.85	0.365	0.00	0.161	0.00	14.656	0.00
1955	3.55	3.44	0.07	1136	1.5	0.15	51.2	1.68	37.3	109.65	0.380	0.00	0.142	0.00	12.496	4.62
1956	4.09	3.96	0.63	995	1.3	0.04	51.7	3.22	31.8	255.09	0.387	0.00	0.123	0.00	13.212	2.06
1957	2.26	2.19	0.96	795	1.1	0.00	50.4	0.24	62.5	218.41	0.369	0.00	0.231	0.00	14.279	0.13
1958	3.73	3.61	0.20	874	1.2	0.00	51.9	3.98	38.3	89.71	0.390	0.00	0.149	0.00	13.412	1.52
1959	2.25	2.18	0.98	1028	1.4	0.06	45.8	16.85	54.3	42.62	0.311	0.00	0.169	0.00	13.461	1.40
1960	3.23	3.13	0.00	1012	1.4	0.05	50.2	0.09	49.8	4.12	0.366	0.00	0.182	0.00	14.949	0.09
1961	3.09	2.99	0.03				48.2	2.91	48.0	0.08	0.340	0.00	0.163	0.00		
1962	3.16	3.06	0.01				52.4	6.22	42.8	24.72	0.397	0.00	0.170	0.00		
1963	2.99	2.89	0.07	682	0.9	0.05	54.7	22.99	44.3	12.05	0.432	0.00	0.191	0.00	11.003	13.26
1964	3.25	3.15	0.00	974	1.3	0.03	50.6	0.48	33.8	195.20	0.372	0.00	0.125	0.00	11.292	11.25
1965	3.25	3.15	0.00	664	0.9	0.06	53.2	10.85	43.8	15.77	0.409	0.00	0.179	0.00	12.548	4.40
1966	3.5	3.39	0.05	1177	1.6	0.20	49.1	0.65	43.3	19.99	0.352	0.00	0.152	0.00	14.656	0.00
1967	2.83	2.74	0.18	529	0.7	0.18	52.2	5.27	47.5	0.05	0.394	0.00	0.187	0.00	12.350	5.27
1968	3.05	2.95	0.05	884	1.2	0.00	50.7	0.63	47.3	0.22	0.373	0.00	0.176	0.00	13.403	1.54
1969							40.2	94.19	76.3	813.88	0.251	0.01	0.191	0.00		
1970	2.67	2.58	0.34	804	1.1	0.00	45.1	23.09	61.5	189.85	0.303	0.00	0.186	0.00	20.021	28.90
1971	2.96	2.86	0.09	963	1.3	0.03	48.2	2.91	55.3	56.68	0.340	0.00	0.188	0.00	16.669	4.10
1972	3.05	2.95	0.05	1035	1.4	0.07	49.3	0.37	50.5	7.72	0.354	0.00	0.179	0.00	14.777	0.02
1973	3.33	3.22	0.00	945	1.3	0.02	51.8	3.59	45.8	3.89	0.389	0.00	0.178	0.00	13.564	1.17
1974	3.79	3.67	0.25	824	1.1	0.00	51.6	2.87	57.0	86.09	0.386	0.00	0.220	0.00	19.907	27.68
1975							51.2	1.68	40.8	48.60	0.380	0.00	0.155	0.00		
1976				755	1.0	0.01	46.8	9.64	47.0	0.52	0.323	0.00	0.152	0.00		
1977				912	1.2	0.01	51.8	3.59	38.5	85.03	0.389	0.00	0.150	0.00		
1978	3.82	3.70	0.28	637	0.9	0.08	50.5	0.35	40.5	52.15	0.370	0.00	0.150	0.00	15.452	0.65
1979	3.91	3.78	0.38	854	1.1	0.00	52.7	7.81	54.3	42.62	0.402	0.00	0.218	0.00	18.471	14.63
1980							48.9	1.01	36.8	120.37	0.349	0.00	0.128	0.00		
1981				794	1.1	0.00	49.2	0.50	53.0	27.86	0.353	0.00	0.187	0.00		
1982				1017	1.4	0.05	48.3	2.58	51.8	16.23	0.341	0.00	0.177	0.00		
1983	3.26	3.15	0.00	841	1.1	0.00	51.4	2.23	45.8	3.89	0.383	0.00	0.175	0.00	13.645	1.00
1984				766	1.0	0.01	45.1	23.09	64.3	273.19	0.303	0.00	0.194	0.00		
1985	3.18	3.08	0.01	649	0.9	0.07	48.6	1.70	47.8	0.00	0.345	0.00	0.165	0.00	15.697	1.10
1986	2.65	2.56	0.36	124	0.2	0.94	48.6	1.70			0.345	0.00				
1987				683	0.9	0.05	50.2	0.09			0.366	0.00				
1988	3.62	3.50	0.11	781	1.0	0.01	53.2	10.85	50.3	6.39	0.409	0.00	0.206	0.00	15.578	0.87
1989	3.62	3.50	0.11	890	1.2	0.00	50.1	0.04	46.5	1.49	0.365	0.00	0.170	0.00	16.026	1.91
MEAN		3.17			1.13		49.91		47.7		0.36		0.17		14.65	
VARIANCE		0.21			0.08		7.55		85.84		0.00		0.00		5.32	
STD DEV		0.46			0.28		2.75		9.26		0.04		0.03		2.31	

NOVEMBER

	PAN E (in./30 days)	(E-Eav)^2	W (Mi./month)	W (Mi./hour)	(W-Wav)^2	T (F)	(T-Tav)^2	RH (%)	(RH-RHav)^2	Ew	(Ew-Ewav)^2	Ea	(Ea-Eaav)^2	C	(C-Cav)^2
1953			1384	1.9	0.17	39.9	6.77	46.8	60.84	0.248	0.00	0.116	0.00		
1954			1314	1.8	0.10	41.7	19.38	41.5	170.30	0.266	0.00	0.110	0.00		
1955			1453	2.0	0.26	33.2	16.79	53.3	1.69	0.190	0.00	0.101	0.00		
1956			1576	2.2	0.47	36.1	1.43	52.8	3.24	0.213	0.00	0.113	0.00		
1957			1226	1.7	0.04	34	10.87	57.8	10.24	0.196	0.00	0.113	0.00		
1958			1124	1.6	0.00	37.4	0.01	49.0	30.80	0.225	0.00	0.110	0.00		
1959			1751	2.4	0.86	35.7	2.55	44.5	101.00	0.210	0.00	0.094	0.00		
1960			1204	1.7	0.03	37.7	0.16	50.8	14.44	0.227	0.00	0.115	0.00		
1961						33.9	11.54	63.5	80.10	0.196	0.00	0.124	0.00		
1962			844	1.2	0.11	41	13.71	51.0	12.60	0.259	0.00	0.132	0.00		
1963			823	1.1	0.13	40	7.30	55.3	0.49	0.249	0.00	0.137	0.00		
1964			1356	1.9	0.14	37.8	0.25	50.5	16.40	0.228	0.00	0.115	0.00		
1965	1.8	0.00	923	1.3	0.05	42.3	25.03	51.5	9.30	0.272	0.00	0.140	0.00	12.101	0.00
1966			878	1.2	0.08	37.7	0.16	60.8	38.44	0.227	0.00	0.138	0.00		
1967			545	0.8	0.56	37.6	0.09	53.8	0.64	0.226	0.00	0.122	0.00		
1968			1301	1.8	0.09	35.8	2.24	62.3	59.29	0.211	0.00	0.131	0.00		
1969						37.7	0.16	60.3	32.49	0.227	0.00	0.137	0.00		
1970						39.2	3.62	63.5	80.10	0.241	0.00	0.153	0.00		
1971						37.6	0.09	58.5	15.60	0.226	0.00	0.132	0.00		
1972						32.6	22.06	62.0	55.50	0.186	0.00	0.115	0.00		
1973						36.0	1.68	57.5	8.70	0.213	0.00	0.122	0.00		
1974						38.1	0.64	59.0	19.80	0.231	0.00	0.136	0.00		
1975						36.5	0.64	56.3	2.89	0.217	0.00	0.122	0.00		
1976						37.1	0.04	49.8	23.04	0.222	0.00	0.110	0.00		
1977						38.5	1.45	52.5	4.20	0.235	0.00	0.123	0.00		
1978						35.9	1.95	55.0	0.20	0.212	0.00	0.116	0.00		
1979						31.0	39.66	70.3	246.49	0.174	0.00	0.122	0.00		
1980						39.2	3.62	48.0	42.90	0.241	0.00	0.116	0.00		
1981						42.7	29.19	41.5	170.30	0.276	0.00	0.115	0.00		
1982						33.9	11.54	58.8	17.64	0.196	0.00	0.115	0.00		
1983			893	1.2	0.07	36.7	0.36	61.0	41.60	0.219	0.00	0.133	0.00		
1984						39.4	4.42	49.8	23.04	0.243	0.00	0.121	0.00		
1985			311	0.4	1.15	28.8	72.20	65.5	119.90	0.159	0.00	0.104	0.00		
1986						37.8	0.25			0.228	0.00				
1987			521	0.7	0.61	38.6	1.70			0.236	0.00				
1988			1159	1.6	0.01	39.8	6.26	49.3	28.09	0.247	0.00	0.122	0.00		
1989						41.1	14.46	46.3	68.89	0.260	0.00	0.120	0.00		
MEAN	1.80			1.50		37.30		54.6		0.23		0.12		12.10	
VARIANCE	ERR			0.27		9.29		47.39		0.00		0.00		ERR	
STD DEV	ERR			0.52		3.05		6.88		0.03		0.01		ERR	

C

APPENDIX C

ROCKY FLATS MONTHLY TOTAL PAN EVAPORATION CALCULATIONS

ROCKY FLATS TOTAL MONTHLY PAN EVAPORATION CALCULATIONS (from June 1989 through June 1990 monthly averages)

MEYER EQUATION

$E = C * (Ew - Ea) * (1 + 0.1 * W)$

C = Meyer Equation Constant, from Ft. Collins Data
E = TOTAL PAN EVAPORATION (INCHES/30 DAYS), at Rocky Flats
W = WIND VELOCITY (MPH), at Rocky Flats, adjusted to an elevation of 1.5 feet
$W (\text{at } 1.5 \text{ ft}) = W (\text{at } 10 \text{ m}) * \{(1.5/32.808)^\wedge(1/7)\}$
T = AIR TEMPERATURE (degrees F), at Rocky Flats
Ew = SATURATION VAPOR PRESSURE CORRESPONDING TO AIR TEMP (INCHES Hg)
$= (0.0041 * T + 0.676)^\wedge 8 - 0.000019 * [T + 16] + 0.001316$
Ea = ACTUAL VAPOR PRESSURE BASED ON AIR TEMP AND RELATIVE HUMIDITY or DEW POINT (INCHES Hg)
$= (0.0041 * Tdew + 0.676)^\wedge 8 - 0.000019 * [Tdew + 16] + 0.001316$

(Total Pan Evaporation is greater than net pan evaporation, which subtracts precipitation)

Month	Year	W (m/s) (at 10 m)	W (mph) (at 10 m)	W (mph) (at 1.5 ft)	T (C)	T (F)	Ew (in. Hg)	Tdew (C)	Tdew (F)	Ea (in. Hg)	C (Ft. Collins)	Rocky Flats Calculated Total Pan E (in./30 days)	Rocky Flats Pan E Total (in./month) (30 or 31 days)	Rocky Flats Measured Total Pan E (in./27 days)
JUNE	1989	2.885	6.45	4.15	14.93	58.87	0.502	1.45	34.61	0.201	17.31	7.37	7.37	
JULY	1989	3.026	6.77	4.36	22.46	72.43	0.803	5.55	41.99	0.268	15.2	11.67	12.06	
AUGUST	1989	3.167	7.08	4.56	19.82	67.68	0.683	6.31	43.36	0.282	14.96	8.72	9.01	
SEPTEMBER	1989	3.003	6.72	4.32	17.182	62.93	0.579	3.282	37.91	0.229	16.02	8.04	8.04	
OCTOBER	1989	3.638	8.14	5.24	9.88	49.78	0.360	-5.267	22.52	0.122	14.65	5.31	5.49	
NOVEMBER	1989	3.628	8.12	5.22	9.9	49.82	0.361	-5.305	22.45	0.122				
DECEMBER	1989	4.769	10.67	6.87	-2.3	27.86	0.153	-12.21	10.02	0.071				
JANUARY	1990	5.853	13.09	8.43	2.633	36.74	0.218	-11.725	10.90	0.074				
FEBRUARY	1990	4.164	9.31	5.99	0.187	32.34	0.183	-10.206	13.63	0.083				
MARCH	1990	3.472	7.77	5.00	2.48	36.46	0.216	-5.955	21.28	0.116				
APRIL	1990	3.825	8.56	5.51	7.03	44.65	0.297	-1.8199	28.72	0.158	24.35	5.24	5.24	
MAY	1990	3.606	8.07	5.19	11.02	51.84	0.389	0.0571	32.10	0.181	19.71	6.20	6.41	
JUNE	1990	3.997	8.94	5.75	20.36	68.65	0.706	3.389	38.10	0.230	17.31	12.97	12.97	
NOVEMBER	1990	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	4.31

ROCKY FLATS TOTAL MONTHLY PAN EVAPORATION CALCULATIONS (from 24-year meteorological monthly averages)

MEYER EQUATION

$$E = C * (Ew-Ea) * (1 + 0.1 * W)$$

C = Meyer Equation Constant, from Ft. Collins Data
E = TOTAL PAN EVAPORATION (INCHES/30 DAYS), at Rocky Flats
W = WIND VELOCITY (MPH), at Rocky Flats, adjusted to an elevation of 1.5 feet
W (at 1.5 ft) = W (at 2 m) * {(1.5/6.562)^(1/7)}
T = AIR TEMPERATURE (degrees F), at Rocky Flats
Ew = SATURATION VAPOR PRESSURE CORRESPONDING TO AIR TEMP (INCHES Hg)
= (0.0041 * T + 0.676)^8 - 0.000019 * [T + 16] + 0.001316
Ea = ACTUAL VAPOR PRESSURE BASED ON AIR TEMP AND RELATIVE HUMIDITY or DEW POINT (INCHES Hg)
= (RH * Ew)/100

(Total Pan Evaporation is greater than net pan evaporation, which subtracts precipitation)

Month (1952-1976)	W (mpd) (at 2 m)	W (mph) (at 2 m)	W (mph) (at 1.5 ft)	T (F)	Ew (in. Hg)	RH (%)	Ea (in. Hg)	C (Ft. Collins)	Rocky Flats Calculated Total Pan E (in./30 days)	Rocky Flats Pan E Total (in./month) (30 or 31 days)	Rocky Flats Measured Total Pan E (in./27 days)
JUNE	121.0	5.04	4.08	65.0	0.622	45	0.280	17.31	8.35	8.35	
JULY	98.3	4.10	3.32	71.0	0.765	45	0.344	15.2	8.52	8.80	
AUGUST	99.8	4.16	3.37	70.0	0.739	42	0.311	14.96	8.58	8.86	
SEPTEMBER	83.2	3.47	2.81	61.0	0.541	44	0.238	16.02	6.22	6.22	
OCTOBER	93.7	3.90	3.16	52.0	0.391	36	0.141	14.65	4.82	4.98	
NOVEMBER	113.4	4.73	3.83	39.5	0.243	47	0.114				
DECEMBER	148.2	6.18	5.00	35.0	0.204	44	0.090				
JANUARY	176.9	7.37	5.97	30.0	0.167	43	0.072				
FEBRUARY	202.6	8.44	6.84	33.5	0.192	48	0.092				
MARCH	155.7	6.49	5.25	36.4	0.215	50	0.108				
APRIL	140.6	5.86	4.74	46.5	0.318	50	0.159	24.35	5.72	5.72	
MAY	110.4	4.60	3.73	53.5	0.413	50	0.206	19.71	5.59	5.77	
NOVEMBER	NA	NA		NA	NA	NA	NA	NA	NA	NA	4.31

D

APPENDIX D

COMPARISON OF ROCKY FLATS AND FORT COLLINS METEOROLOGICAL DATA

COMPARISON OF ROCKY FLATS (RF) & FORT COLLINS (FTC) METEOROLOGICAL CONDITIONS

(RF 1989-1990 MONTHLY AVERAGES vs. FTC 1953-1989 MONTHLY AVERAGES)

TOTAL PAN E = C * (Ew-Ea) * (1 + 0.1 * W)

Month	RF (W) (mph)	FTC (W) (mph)	RF T (F)	FTC T (F)	RF Ew (in Hg)	FTC Ew (in Hg)	RF Tdew (F)	RF RH (%)	DENVER RH (%)	RF Ea (in Hg)	FTC Ea (in Hg)	RF Total Pan E (in./30 days)	FTC Total Pan E (in./30 days)	RF Pan E Total (in./month) (30 or 31 days)	FTC Pan E Total (in./month) (30 or 31 days)
JUNE	4.95	1.45	63.76	65.8	0.596	0.64	36.36	36.07	48.5	0.215	0.31	10.17	6.48	10.17	6.48
JULY	4.36	1.26	72.43	71.52	0.803	0.78	41.99	33.39	47.3	0.268	0.37	11.67	7.01	12.06	7.24
AUGUST	4.56	1.16	67.68	69.29	0.683	0.72	43.36	41.37	48.5	0.282	0.35	8.72	6.10	9.01	6.30
SEPTEMBER	4.32	1.28	62.93	60.34	0.579	0.53	37.91	39.49	47.6	0.229	0.25	8.04	4.90	8.04	4.90
OCTOBER	5.24	1.13	49.78	49.91	0.360	0.36	22.52	33.89	47.7	0.122	0.17	5.31	3.17	5.49	3.27
NOVEMBER															
DECEMBER															
JANUARY															
FEBRUARY															
MARCH															
APRIL	5.51	2.48	44.65	47.01	0.297	0.33	28.72	53.25	48.8	0.158	0.16	5.24	4.95	5.24	4.95
MAY	5.19	1.74	51.84	56.36	0.389	0.46	32.10	46.69	51.4	0.181	0.23	6.20	5.48	6.41	5.66
AVG (JUN-OCT & APR-MAY)	4.88	1.50	59.01	60.03	0.529	0.55		40.59	48.54	0.21	0.26	7.91	5.44	8.06	5.54
SUM (JUN-OCT & APR-MAY)														56.41	38.80
% DIFFERENCE	225.05%		-1.70%		-2.98%			-16.38%		-20.89%		45.31%		45.40%	
RESERVOIR SUM w/0.7														39.49	27.16
RESERVOIR SUM w/0.74														41.75	28.71

E

APPENDIX E

COMPARISON OF TOTAL PAN EVAPORATION (JANUARY 1948 THROUGH DECEMBER 1990)

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/48	0.69								
02/28/48	0.86								
03/31/48	1.36								
04/30/48	4.57								
05/31/48	6.71								
06/30/48	7.81								
07/31/48	9.74								
08/31/48	8.36								
09/30/48	7.29								
10/31/48	5.31								
11/30/48	2.41								
12/31/48	1.01								
01/31/49	0.66								
02/28/49	0.89								
03/31/49	1.36								
04/30/49	4.03								
05/31/49	6.29								
06/30/49	7.56								
07/31/49	8.33								
08/31/49	8.24								
09/30/49	6.59								
10/31/49	4.39								
11/30/49	2.66								
12/31/49	0.99								
01/31/50	0.76								
02/28/50	0.89								
03/31/50	1.79								
04/30/50	4.17								
05/31/50	6.63								
06/30/50	8.71								
07/31/50	8.29								
08/31/50	8.41								
09/30/50	5.26								
10/31/50	5.89								
11/30/50	2.27								
12/31/50	0.99								
01/31/51	0.74								
02/28/51	0.86								
03/31/51	1.66								
04/30/51	3.83								
05/31/51	6.81								
06/30/51	7.47								
07/31/51	9.10								
08/31/51	8.03								
09/30/51	6.40								
10/31/51	8.63								
11/30/51	2.36								
12/31/51	1.01								
01/31/52	0.77								
02/28/52	0.90								
03/31/52	1.41								
04/30/52	4.01								
05/31/52	6.30								
06/30/52	9.41								
07/31/52	10.06								
08/31/52	8.14								
09/30/52	7.36								
10/31/52	5.73								
11/30/52	2.19								
12/31/52	1.01								

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/53	0.79								
02/28/53	0.89								
03/31/53	1.81								
04/30/53	3.81	3.17							
05/31/53	7.00	5.53						9.77	
06/30/53	8.86	6.73						14.43	
07/31/53	9.01	6.96						14.84	
08/31/53	8.13	6.68						11.94	
09/30/53	8.13	6.61						11.83	
10/31/53	5.34	3.92						8.18	
11/30/53	2.41								
12/31/53	1.01								
01/31/54	0.74								
02/28/54	0.94								
03/31/54	1.54								
04/30/54	4.84	6.48						11.03	
05/31/54	7.09	5.69						8.49	
06/30/54	9.59	8.35						16.76	
07/31/54	9.79	8.95						17.16	
08/31/54	8.34	7.2						13.39	
09/30/54	6.90	5.63						12.07	
10/31/54	4.99	3.58						6.2	
11/30/54	2.53								
12/31/54	0.99								
01/31/55	0.70								
02/28/55	0.86								
03/31/55	1.69								
04/30/55	5.10	6.92						11.13	
05/31/55	7.97	7.69						12.1	
06/30/55	8.31	5.28						10.5	
07/31/55	10.57	8.71						16.69	
08/31/55	7.94	6.16						14.86	
09/30/55	6.70	5.44						10.35	
10/31/55	5.46	3.55						7.04	
11/30/55	2.27								
12/31/55	1.01								
01/31/56	0.74								
02/28/56	0.86								
03/31/56	1.81								
04/30/56	4.20	4.22						7.47	
05/31/56	7.31	5.19						10.75	
06/30/56	9.74	7.95						15.92	
07/31/56	9.71	7.66						12.69	
08/31/56	8.21	6.06						10.58	
09/30/56	8.00	6.21			13.43			10.94	
10/31/56	5.83	4.09			10.34			8.57	
11/30/56	2.27								
12/31/56	1.01								

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/57	0.70								
02/28/57	0.89								
03/31/57	1.46								
04/30/57	3.50	2.71							
05/31/57	6.07	4.92			8.98			7.41	
06/30/57	8.60	6.33			11.22			8.83	
07/31/57	9.01	7.13			13.42			11.6	
08/31/57	7.99	6.14			11.55			11.24	
09/30/57	6.76	5.06			9.56			7.81	
10/31/57	3.71	2.26			5.57			4.35	
11/30/57	2.17								
12/31/57	0.93								
01/31/58	0.76								
02/28/58	0.87								
03/31/58	1.13								
04/30/58	4.01	4.28						5.98	
05/31/58	6.89	5.08			9.94			8.75	
06/30/58	8.11	6.52			12.46			11.13	
07/31/58	8.34	6.14			11.36			9.17	
08/31/58	8.31	7.11			11.88			10.62	
09/30/58	6.90	5.45			10.61			9.39	
10/31/58	5.39	3.73			7.76			7.31	
11/30/58	2.36								
12/31/58	1.01								
01/31/59	0.70								
02/28/59	0.84								
03/31/59	1.51								
04/30/59	4.23	4.72						7.73	
05/31/59	6.50	4.91			11.55			8.18	
06/30/59	8.99	6.14			12.21			13.44	
07/31/59	10.71	7.26			14.68			14.46	
08/31/59	8.34	6.43			11.89			13.45	
09/30/59	7.11	4.97			11.22			10.64	
10/31/59	4.29	2.25			6.06			5.34	
11/30/59	2.46								
12/31/59	1.00								
01/31/60	0.71								
02/28/60	0.86								
03/31/60	1.54								
04/30/60	4.60	5.39						8.62	
05/31/60	7.36	5.17			10.87			9.5	
06/30/60	8.70	7.15			12.48			9.48	
07/31/60	9.89	7.65			13.82			13.09	
08/31/60	8.56	8.15			16.03			14.46	
09/30/60	6.94	5.93			10.33			9.75	
10/31/60	4.59	3.23			6.58			6.36	
11/30/60	2.31								
12/31/60	1.06								

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/61	0.71								
02/28/61	0.86								
03/31/61	1.29								
04/30/61	4.03	4.26						6.9	
05/31/61	5.53	4.56			11.11			7.68	
06/30/61	8.09	4.78			12.3			10.55	
07/31/61	8.76	5.46			13.24			12.37	
08/31/61	7.87	5.07			11.18			10.9	
09/30/61	5.14	3.19			9.29			7.61	
10/31/61	4.71	3.09			7.45			5.71	
11/30/61	2.04								
12/31/61	1.01								
01/31/62	0.71								
02/28/62	0.86								
03/31/62	1.51								
04/30/62	4.33							8.75	
05/31/62	7.70	5.37			14.03			12.3	
06/30/62	8.26	4.94			11.89			10.59	
07/31/62	9.31	5.61			12.87			11.89	
08/31/62	8.56	5.33			15.17			11.03	
09/30/62	6.34	4.45			8.49			7.22	
10/31/62	5.09	3.16			8.24			6.16	
11/30/62	2.31								
12/31/62	1.01								
01/31/63	0.71								
02/28/63	0.89								
03/31/63	1.53								
04/30/63	4.76							10.18	
05/31/63	7.94	5.17			13.9			10.25	
06/30/63	8.46	6.16			15.99			15.79	
07/31/63	9.64	6.99			17.28			15.62	
08/31/63	7.47	4.41			12.96			12.26	
09/30/63	5.60	4.5			9.65			7.73	
10/31/63	4.97	2.99			9.07			7.11	
11/30/63	2.21								
12/31/63	1.04								
01/31/64	0.74								
02/28/64	0.87								
03/31/64	1.44								
04/30/64	4.14								
05/31/64	7.54	5.86			13.06			11.18	
06/30/64	7.87	5.14			14.01			11.44	
07/31/64	10.33	6.34			15.44			15.57	
08/31/64	8.57	5.99			13.65			13.77	
09/30/64	6.90	4.46			9.33			9.71	
10/31/64	5.70	3.25			8.09			7.06	
11/30/64	2.33								
12/31/64	1.01								

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/65	0.71								
02/28/65	0.83								
03/31/65	1.10								
04/30/65	4.26							7.93	
05/31/65	6.87	4.16			12.33			10.94	
06/30/65	7.23	4.39			10.85			9.58	
07/31/65	7.94	5.56			12.35			11.64	
08/31/65	7.94	5.48			10.13			9.19	
09/30/65	4.89	3.75			7.13			4.74	
10/31/65	5.01	3.25			6.33			5.74	
11/30/65	2.31								
12/31/65	1.03								
01/31/66	0.77								
02/28/66	0.86								
03/31/66	1.71								
04/30/66	3.90							5.92	
05/31/66	7.94	6.12			11.91			10.69	
06/30/66	8.00	6.04			13.43			11.88	
07/31/66	9.01	7.12			13.35			13.25	
08/31/66	7.93	6.44			10.3			10.33	
09/30/66	5.91	4.7			7.58			8.68	
10/31/66	5.04	3.5			6.26			6.48	
11/30/66	2.10								
12/31/66	1.03								
01/31/67	0.71								
02/28/67	0.89								
03/31/67	1.60								
04/30/67	4.17	5.53						9.51	
05/31/67	5.49	3.97			9.47			7.16	
06/30/67	6.09	2.81			9.53			7.76	
07/31/67	6.63	4.23			9.85			9.62	
08/31/67	7.99	5.14			9.45			11.02	
09/30/67	6.21	3.54			7.66			8.26	
10/31/67	4.74	2.83			7.46			7.43	
11/30/67	2.26								
12/31/67	1.04								
01/31/68	0.61								
02/28/68	0.80								
03/31/68	1.40								
04/30/68	5.34								
05/31/68	6.50				8.91			8.42	
06/30/68	9.40	6.52			13.89			13.52	
07/31/68	9.89	6.3			12.66			11.21	
08/31/68	7.21	5.76			10.65			9.78	
09/30/68	6.10	4.57			9.52			8.26	
10/31/68	4.97	3.05			7.59				
11/30/68	2.20								
12/31/68	1.10								

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/69	0.63								
02/28/69	0.64								
03/31/69	0.54								
04/30/69	5.70							7.69	
05/31/69	6.31				8.57			8.58	
06/30/69	6.57	4.68			9.17			9.74	
07/31/69	7.81	6.60			11.41			12.27	
08/31/69	8.64	6.60			11.66			10.5	
09/30/69	5.74	5.00			6.77			6.79	
10/31/69	3.60				3.65				
11/30/69	2.30								
12/31/69	1.20								
01/31/70	0.70								
02/28/70	0.74								
03/31/70	1.50								
04/30/70	4.50							7.69	
05/31/70	7.20				9.87			10.34	
06/30/70	8.84	5.69			12.87			11.33	
07/31/70	8.60	6.76			11.72			10.85	
08/31/70	8.20	5.78			11.52			11.26	
09/30/70	6.31	4.70			7.79			8.44	
10/31/70	3.01	2.67			3.97				
11/30/70	1.90								
12/31/70	1.70								
01/31/71	0.70								
02/28/71	0.80								
03/31/71	1.80								
04/30/71	3.50							6.62	
05/31/71	6.70				9.16			7.49	
06/30/71	8.77	5.74			13.77			9.72	
07/31/71	7.97	6.35	11.15		11.95			10.65	
08/31/71	8.31	6.54	11.44		10.54			11.18	
09/30/71	6.03	4.76	9.19		10.24			8.57	
10/31/71	4.50	2.96	7.49		6.72			6.5	
11/30/71	2.30								
12/31/71	1.00								
01/31/72	0.80								
02/28/72	0.80								
03/31/72	1.50								
04/30/72	3.80		8.99					6.29	
05/31/72	6.60	5.13	10.31		10.42		10.28	9.09	
06/30/72	7.94	6.25	13.21		11.78		11.88	9.16	
07/31/72	8.74	6.20	11.64		11.09		11.43	9.37	
08/31/72	8.70	5.67	12.15		9.61		11.18	9.63	
09/30/72	5.26	4.66	7.57		8.04		8.16	7.39	
10/31/72	4.27	3.05	5.27		4.99		5.14	4.83	
11/30/72	2.50								
12/31/72	0.80								

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/73	0.70								
02/28/73	1.70								
03/31/73	1.80								
04/30/73	3.50							5.57	
05/31/73	6.80		8.51		8.44		8.85	8.16	
06/30/73	8.57		12.67		12.48		12.09	11.33	
07/31/73	8.21	6.51	13.05		11.53		12.03	11.15	
08/31/73	8.34	6.83	11.97		13.78		13.11	12.33	
09/30/73	5.37	4.47	9.21		8.32		7.63	5.7	
10/31/73	4.10	3.33	6.68		6.45		5.72	4.8	
11/30/73	1.76								
12/31/73	0.80								
01/31/74	0.80								
02/28/74	0.80								
03/31/74	1.50								
04/30/74	4.00		10.1					7.1	
05/31/74	8.31	7.92	13.76		13.32		11.08	9.99	
06/30/74	7.50	7.16	13.14		13.38		12.75	10.86	
07/31/74	9.70	7.84	14.19		15.86		15.21	15.17	
08/31/74	7.89	6.74	10.37		10.74		11.37	10.19	
09/30/74	5.69	4.67	8.58		8.76		8.74	7.73	
10/31/74	3.97	3.79	5.80		6.37		6.29	5.39	
11/30/74	1.80								
12/31/74	0.80								
01/31/75	0.80								
02/28/75	0.80								
03/31/75	1.00								
04/30/75	3.50		9.81						
05/31/75	5.99		11.42		11.66		9.63	9.09	
06/30/75	7.89	6.96	12.47		11.79		10.16		
07/31/75	9.46	7.72	12.61	12.56	13.26		13.34	12.72	
08/31/75	8.33	7.40	12.61	12.95	13.62		12.63	11.16	
09/30/75	6.23		9.25	9.17	10.18		9.06		
10/31/75	6.43		7.94	7.4	8.99		7.35	7.43	
11/30/75	2.00								
12/31/75	0.80								
01/31/76	0.60								
02/28/76	1.20								
03/31/76	1.90								
04/30/76	3.60		8.38	7.81					
05/31/76	5.86		9.66	9.17	9.45		10.41	9	
06/30/76	8.80	7.56	12.94	12.86	12.34		12.94	11.86	
07/31/76	9.69	7.95	13.27	13.05	13.72		14.7	11.45	
08/31/76	7.71	6.08	10.98	11.47	12.02		12.7	11.65	
09/30/76	5.40	4.22	7.89	7.41	7.76		8.38	7.5	
10/31/76	3.54			5.43	4.84				
11/30/76	2.00								
12/31/76	0.80								

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/77	0.60								
02/28/77	0.66								
03/31/77	1.60								
04/30/77	3.10			7.4			6.65		
05/31/77	8.06		11.63	11.16	10.11		11.17		
06/30/77	9.04	8.53	11.9	12.35	11.23		12.38	9.78	
07/31/77	8.93	9.34	12.42	11.95	13.8		14.13	12.37	
08/31/77	7.34	6.06	8.59	9.85	10.21		10.2	8.11	
09/30/77	8.16	6.24	8.89	9.44	8.76		11.13	8.6	
10/31/77	6.13		7.57	6.51	6.7		7.33	5.69	
11/30/77	2.10								
12/31/77	1.30								
01/31/78	0.70								
02/28/78	0.87								
03/31/78	1.60								
04/30/78	5.59	5.51	9.2	9.99			9.04		
05/31/78	6.69	6.75	12.22	9.68	9.56		9.44	8.28	
06/30/78	8.76	7.58	12.25	12.34	11.8		11.97	10.91	
07/31/78	10.54	7.63	14.01	14.9	15.71		15.87	13.02	
08/31/78	8.96	7.04	11.94	12.17	13.35		11.47	9.66	
09/30/78	8.64	6.07	10.85	10.55	10.55		11.87		
10/31/78	5.69	3.82	6.57	6.62	7.17		7.61		
11/30/78	2.70								
12/31/78	0.90								
01/31/79	0.70								
02/28/79	0.90								
03/31/79	1.60								
04/30/79	3.20			9.39			8.49		
05/31/79	6.00	5.28	10.72	8.89	7.15		7.1		
06/30/79	8.20	5.50	11.49	11.06	10.96		9.97		
07/31/79	9.33	6.45	12.02	12.27	12.35		12.4		
08/31/79	7.97	5.26	10.28	10.08	11.39		11.41		
09/30/79	6.49	5.27	9.33	8.99	9.14		9.75		
10/31/79	4.46	3.91		6.24	7.29		7.6		
11/30/79	2.00								
12/31/79	0.90								
01/31/80	0.70								
02/28/80	0.90								
03/31/80	1.60								
04/30/80	3.20								
05/31/80	6.74		7.96	8.64	7.55		7.86		
06/30/80	10.33		12.75	13.34	12.85		12.74		
07/31/80	11.06		15.93	14.18	15.67		14.33		
08/31/80	8.46		12.4	11.97	14.18		11.77		
09/30/80	7.04		9.74	8.37	10.3		9.47		
10/31/80	5.80			6.77	7.28		7.58		
11/30/80	2.70								
12/31/80	1.00								

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/81	0.80								
02/28/81	0.90								
03/31/81	1.60								
04/30/81	5.14			8.93			7.92		
05/31/81	5.46		10.11		9.18		6.64		
06/30/81	8.71	8.35	14.82	13.43	13.83		10.61		
07/31/81	9.53	8.9	13.39	13.22	11.55		11.74		
08/31/81	7.17	6.24	9.93	10.37	10.01		8.83		
09/30/81	6.74	5.49	8.8	8.15	8.7		9.56		
10/31/81	4.00			6.13	5.49		5.63		
11/30/81	2.70								
12/31/81	0.90								
01/31/82	0.70								
02/28/82	0.90								
03/31/82	1.70								
04/30/82	4.00			9.19			9.05		
05/31/82	5.91		9.7	8.75	9.86		9.12		
06/30/82	7.26	7.78	9.83	9.64	11		8.33		
07/31/82	9.40	9.1	6.80		13.61		13.17		
08/31/82	7.29	7.55	9.33	8.79	12.79		9.38		
09/30/82	5.79	3.98	8.19	6.57	8.88		7.63		
10/31/82	3.67			4.73	6.45		5.25		
11/30/82	2.70								
12/31/82	0.90								
01/31/83	0.70								
02/28/83	0.90								
03/31/83	1.60								
04/30/83	3.20			7.85					
05/31/83	5.00		8.81	9.37	8.78		7.31		
06/30/83	4.29	6.63	9.79	10.58	10.58		8.12		
07/31/83	10.40	7.82	12.42	13.93	15.4		11.18		
08/31/83	8.59	6.80	11.86	11.76	13.3		11.8		
09/30/83	8.86	5.41	9.52	9.55	9.71		10.4		
10/31/83	8.07	3.26	6.27	5.78	6.01		6.71		
11/30/83	2.70								
12/31/83	0.90								
01/31/84									
02/28/84									
03/31/84									
04/30/84		4.81		6.56					
05/31/84		6.84	10.56	9.73	9.18		9.93		
06/30/84		6.08	11.61	10.89	10.91		10.42		
07/31/84		7.97	13.18	12.12	15.38		12.62		
08/31/84		6.41	10.72	9.83	10.42		10.98		
09/30/84		4.67	8.65	8.15	9.07		8.15		
10/31/84					3.49		4.08		
11/30/84									
12/31/84									

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/85									
02/28/85									
03/31/85									
04/30/85		5.38		7.37			8.2		
05/31/85		6.64	9.59	8.77	9.15		8.58		
06/30/85		7.49	12.16	10.56	13.25		11.62		
07/31/85		6.37	12.14	9.98	13.37		13.02		
08/31/85		6.83	11.37	9.95	11.23		11.55		
09/30/85		4.70	7.82	7.47	8.23		7.46		
10/31/85		3.18	5.84		5.43				
11/30/85									
12/31/85									
01/31/86									
02/28/86									
03/31/86									
04/30/86		4.26		7.48			5.68		
05/31/86		5.57	9.54	9.12	10.76		8.26		
06/30/86		7.45	10.16	10	10.29		10.54		
07/31/86		7.64	12.71	12.06	14.3		10.39		
08/31/86		6.39	9.97	9.97	11.89		11.4		
09/30/86		4.03	6.78	6.59	7.44		7.1		
10/31/86		2.65	5.26	4.21	4.41		4.61		
11/30/86									
12/31/86									
01/31/87									
02/28/87									
03/31/87									
04/30/87		5.54		8.01			9.65		
05/31/87		5.34	8.58	7.34	7.14		7.15		
06/30/87		7.63	11.93	10.51	9.7				
07/31/87		9.72	12.37	12.66	13.32		13.59		
08/31/87		6.50	9.62	9.12	9.33		9.4		
09/30/87		4.53	7.24	7.46	7.57		9.01		
10/31/87			6.36		5.71				
11/30/87									
12/31/87									
01/31/88									
02/28/88									
03/31/88									
04/30/88		5.14		7.59			7.83	6.7	
05/31/88			10.92		9.08		10.67	9.97	
06/30/88		8.24	11.35	11.71	10.67		11.96	11.5	
07/31/88		7.32	11.40	11.08	12.31		12.61		
08/31/88		6.33	11.48	10.06	11.63		12.3	12.11	
09/30/88		5.61	8.21	7.83	7.75		9.07	8.39	
10/31/88		3.62	6.04	5.26	5.48		6.77	5.84	
11/30/88									
12/31/88									

COMPARISON OF TOTAL MONTHLY PAN EVAPORATION (inches/month) [January 1948 thru December 1990]

MONTH ENDING	CHERRY CREEK DAM	FORT COLLINS	PUEBLO WSO AP	PUEBLO RESERVOIR	SPRINGFIELD 7 WSW	TRINIDAD LAKE	AKRON 4 E	BONNY LAKE	ROCKY FLATS (Calc.)
01/31/89									
02/28/89									
03/31/89									
04/30/89		5.77		7.89			8.56	6.97	
05/31/89		6.98	9.4	9.86	9.95		11.43	9.77	
06/30/89		6.18	10.4	9.53	8.18		9.72	9.61	7.37
07/31/89		8.44	13.40	13.27	11.87	12.22	15.95	12.87	12.06
08/31/89		6.22	10.01	10.02	9.38	8.55	11.21	9.08	9.01
09/30/89		4.73	8.38	7.99	6.77	6.26	8.55	7.31	8.04
10/31/89		3.62		5.95	5.97	5.62	7.68		5.49
11/30/89									
12/31/89									
01/31/90									
02/28/90									
03/31/90									
04/30/90									5.24
05/31/90									6.41
06/30/90									12.97
07/31/90									
08/31/90									
09/30/90									
10/31/90									
11/30/90									
12/31/90									